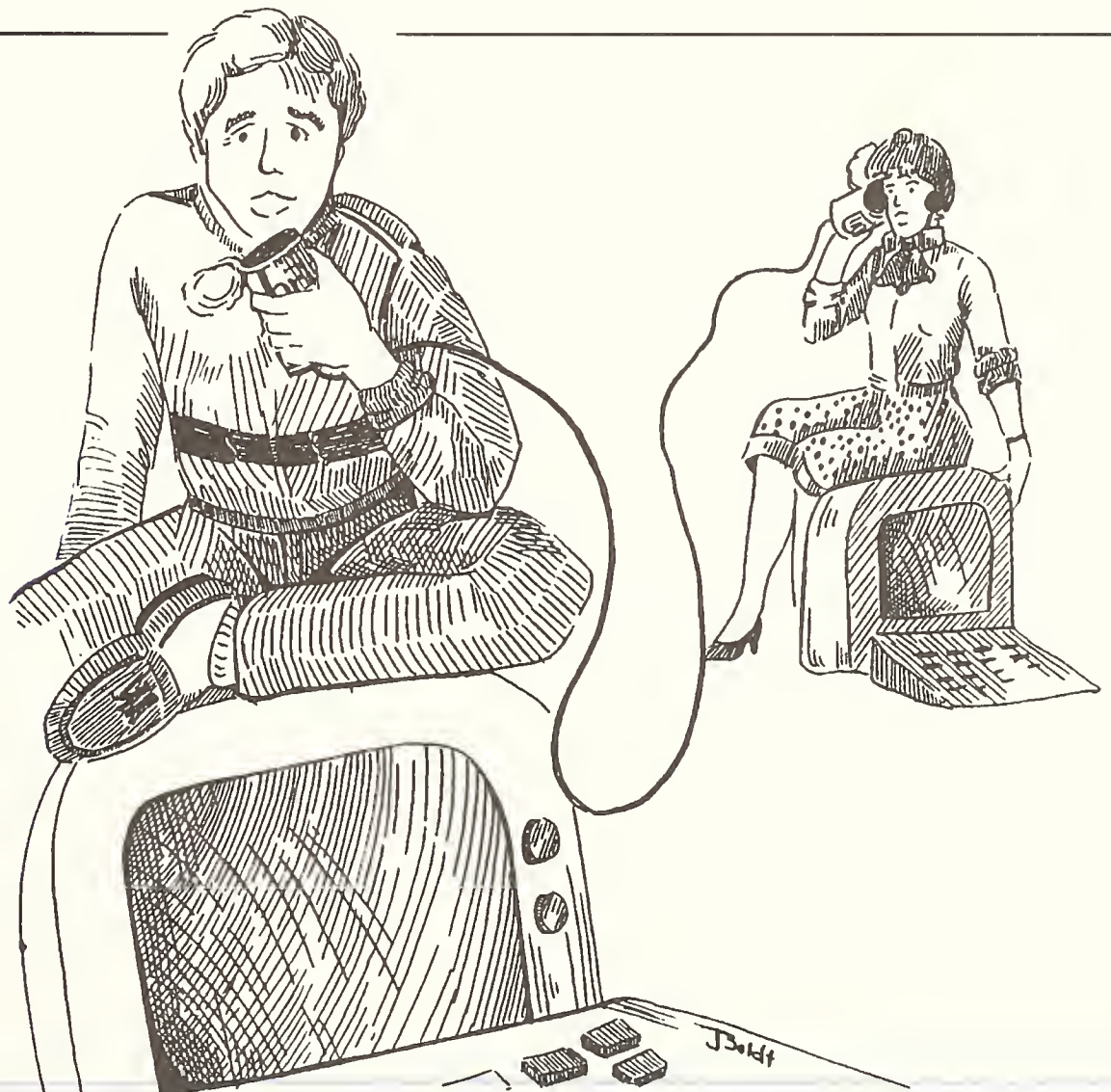

Excerpts from The 1989/90 UTCS Annual Plan

State of the '386s
SAS Renewal
Hardware and Software Reviews

Computer Networking



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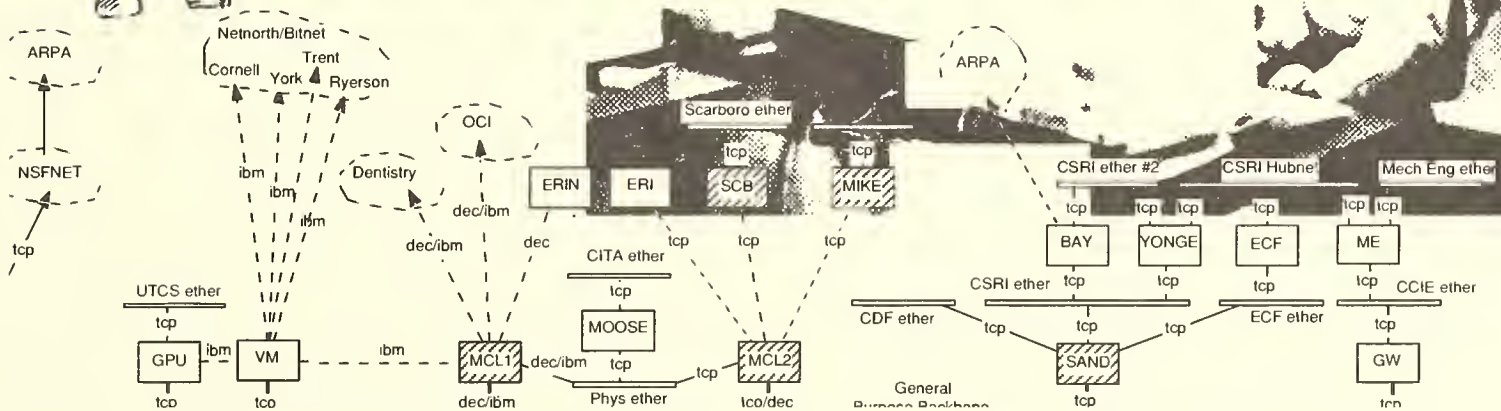
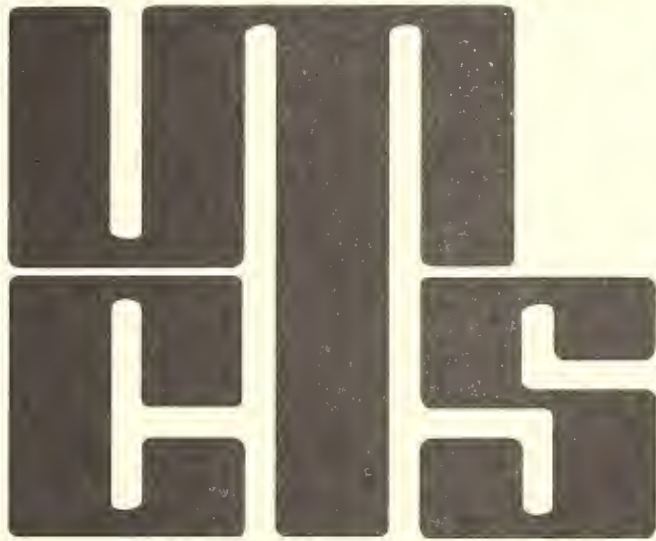
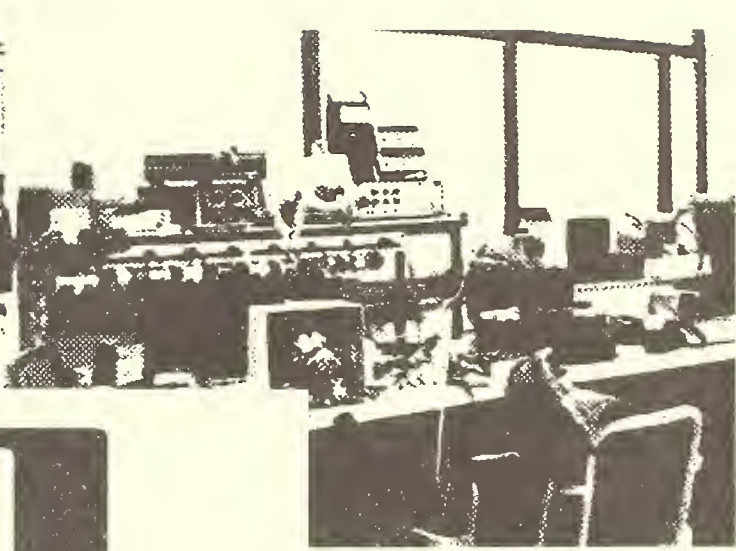
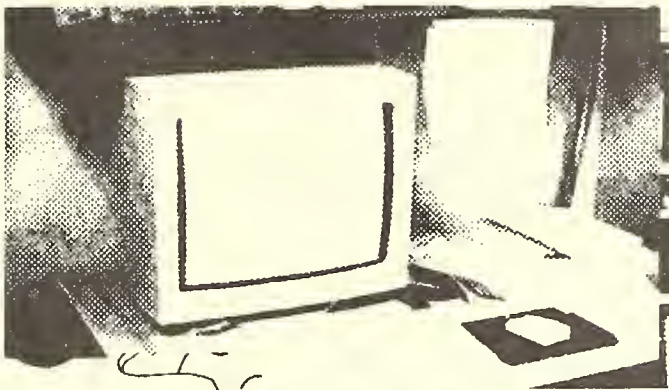
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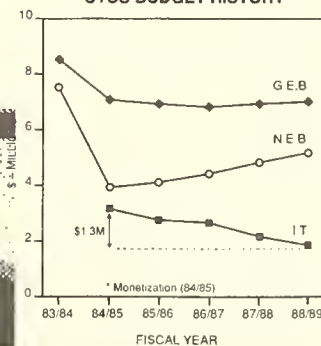
UNIVERSITY OF TORONTO COMPUTING SERVICES 1989 / 1990 ANNUAL PLAN

Dr. Warren Jackson, Director
Prepared by:

March 17, 1989
Warren Jackson and Eugene Siciunas



Figure 1
UTCS BUDGET HISTORY



Excerpts from the 1989/90 UTCS Annual Plan

This issue of *ComputerNews* incorporates major excerpts from the 1989/90 UTCS Annual Plan. We produce a document every year which we call a plan, but which is quite a bit more. It contains a section on our strategic directions, an annual report of activities and projects from the previous year, a financial summary from the previous year, financial projections for the new year, and sections on various areas of activity, including suggested projects. We use our plan as both a review and a vehicle to suggest specific projects which are consistent with our strategic directions and with the evolution of computing and communications on campus. Our plan is used to lobby for funding for projects, and this year we have been successful (subject always to final approval) in obtaining approval for a number of networking initiatives. I would like to acknowledge the valuable advice and feedback we receive from our Board in the preparation and review of the Plan and in prioritizing projects.

Dr. Warren C. Jackson, Director

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1. INTRODUCTION

The 1989/90 Annual Plan documents the continuing extension of the three backbone communications networks and the first steps in their integration. Value added services, such as enhanced connectivity for the IBM domain, are beginning to be offered. We are becoming involved in a number of network-based services which could, in total, be considered the start of a global academic information system or data base. UTCS activities in a number of external networking initiatives establish a central role for the University in Ontario and national networks, as well as in connecting to other international networks.

The central academic computing services UTCS offers continue to evolve toward a combination of an IBM VM system and increasingly powerful UNIX systems.

We appear to be finally approaching a situation where we have a stable, balanced budget for most basic functions. Our mandate and strategic directions have been modified to reflect our continuing evolution, and are listed in the next section.

2. STRATEGIC DIRECTIONS

We have regularly presented our view of where UTCS should fit in the University, based on a mandate and a set of strategic directions which have been reviewed and refined regularly over the past four annual plans. This year we feel a fairly major revision is in order. The basic thrust is still quite robust, but changing circumstances mean that they need to be regularly monitored and modified for relevance. This section will present a modified mandate and strategic directions.

2.1 Mandate and Basic Operating Principles

The mandate of UTCS is to encourage and support the use of information technologies across campus, to plan, implement and operate *common-carrier* networks and certain appropriate central computer facilities.

In carrying out this mandate, certain basic operating principles must be observed:

- A. The focus of UTCS' effort will be on the planning, implementation, support and integration of systems and networks based on existing and emerging academic and/or administrative needs. UTCS' activities will all be in support of services which are explicitly defined in terms of resources, results, costs and the source of funds to pay for them.
- B. Certain of UTCS' services will be centrally funded or subsidized; the rest will be operated on a partial or full cost-recovery basis, with UTCS having the flexibility to introduce, modify or discontinue self-funding services as it deems appropriate.
- C. The campus backbone network will continue to be designed to insulate the user-owned local networks which it connects from changes in backbone technology and protocols.
- D. Facilities will be provided which are compatible with vendor independent standards whenever possible.

2.2 Strategic Directions

In accordance with this mandate and subject to these operating principles, we identify a few strategic directions against which our activities, expenditures and annual plans should be tested. These directions reflect changes in information technologies, user attitudes, and the degree of decentralization of computing decisions seen on our campus.

- A. UTCS will continue to expand the campus backbone network infrastructure, planning for a single, pervasive, coherent, integrated networking environment which conforms to international standards.
- B. UTCS will take a leading role in encouraging the development of high bandwidth external networks which allow intimate connections to other campus networks and will support, operate, and implement institutional external network connections.

- C. To better support U of T network users, UTCS will continue to commit resources to external network connections and topologies in which U of T has a central hub location.
- D. In support of networking services, UTCS will have to maintain at least one integrated computer/communications environment.
- E. UTCS will support application packages that allow users flexibility in storing and processing data at the most efficient place on the campus computer network.
- F. Consulting, planning, implementation and management for both academic and local administrative systems and networks will continue to be an important area of UTCS service.
- G. A major thrust of UTCS activities will continue to be to provide access to, and advising and support services for, microcomputers and the more modest examples of the latest technology likely to be within the financial reach of the individual researcher or small department.
- H. UTCS will continue to present courses to the University community on the latest developments in information technology and on actual useful techniques and operational packages. UTCS will collaborate in certain areas with the School of Continuing Studies on teaching courses externally.
- I. UTCS will, with the library, coordinate, support and provide general university public access to increasing amounts of academic and research-oriented information and data via the campus and external networks. Common user interfaces will be provided whenever possible.
- J. In conjunction with the organizations that develop central administrative and registrarial systems, increased access to administrative and registrarial data will be available via the network, consistent with security and integrity requirements.
- K. UTCS will continue to plan, operate and support the administrative computing facility.

- L. A number of facilities are likely to be specifically, but not necessarily uniquely, provided and supported by UTCS because of their high cost to divisional units. These might include supercomputing services, large-scale data storage and staging, high-quality print or graphics devices, fourth generation languages, scanners, some public data bases, and tape storage and retrieval.

These directions support a continuing shift away from the image UTCS has had of being primarily an operator of large machines for academic services. The increased emphasis on microcomputer hardware and software support and consulting, facilities management, and networking reflects these changes.

3. BASIC ASSUMPTIONS AND TIMING

Our plan is based on the following assumptions and timing:

3.1 The Central Administrative Computer

The central administrative computer was upgraded from an IBM 4381 R03 to an R14 in late 1987. This upgrade provided approximately 25 to 35 percent more processing power. The technical subcommittee of the Administrative Computing Committee is recommending an upgrade in capacity based on processing growth figures of 25 to 40 percent per year compounded. We assume that funding will be available to upgrade the system to one that is at least two and a half times as powerful during Summer 1989.

3.2 Academic Computing Services

We will continue to treat VM/CMS as the preferred UTCS delivery vehicle for providing academic mainframe computing services. We assume that the use and income of our IBM VM academic service has stabilized, and that additional uses for networking and the data archive and

academic information data base will mean that the VM service will continue in operation for the foreseeable future. If new initiatives and services based on VM are successful, the present machine, an IBM 4381 R02, may have to be replaced with one of greater capacity at some point.

3.3 UNIX Services

We will accommodate time-sharing UNIX users on our upgraded SUN 3/280. The new SUN 3/280 we added in 1988/89 will be used primarily for networking.

3.4 Communications and Network Services

We will assume again this year that, for at least the near term, there will continue to be a heterogeneous networking environment on campus. Steps have been taken and continue to bridge the three major (mostly academic) backbone networks (General Purpose or Ethernet-based; terminal switching or PACX-based; IBM token ring backbone) and the network centered on the IBM administrative computer. The 1989/90 plan includes additional connections. By the end of the 1989/90 fiscal year, nearly universal connectivity for and between users on the different networks should be available, utilizing relatively transparent gateways and bridges between the networks.

We will extend the backbone network and required physical infrastructure as funding and resources permit. The capabilities of the backbone will be upgraded as the technology becomes available and as funding permits.

4. 1988/89 ANNUAL REPORT

4.1 Activity Summary

Throughout 1988, UTCS continued to be active in networking, connecting to international and regional networks, as well as those within the University.

NSFnet Connection

In May 1988, UTCS received \$30,000 of base funding for a 56 Kbps link to NSFnet, via Cornell University in Ithaca, New York. This was insufficient to cover all the costs of this link, which were closer to \$66,000 per year. A proposal was made to the NetNorth Executive Committee to physically multiplex a 19.2 Kbps channel from the 56 Kbps and use it to connect NetNorth to BITNET for the same price they were now paying for a 9.6 Kbps link from Guelph. The proposal was accepted and another \$20,000 of the cost of the link was funded. Some reconfiguration of east- and west-bound NetNorth links that previously went to Guelph was required to reflect the emergence of Toronto as a hub and minimize the number of hops for distant users to get to the U.S. The installation of the link to Cornell was delayed by the summer Bell strike, but it was functional by October 14 (at least that's when billing started). The reconfiguration of other NetNorth links and updates to affected routing tables will take until February to complete.

CSRI was finally successful in installing their connection to the ARPAnet via a direct 9.6 Kbps channel to the University of Rochester. UTCS' connection is one hop less direct, since it passes through Cornell first, but is of considerably greater bandwidth.

ONet (Ontario Regional Network)

The Ontario regional network, now called ONet, came into being when the computing organizations at Toronto, Western, McMaster, Waterloo, Queens, and York universities decided to contribute cisco routers and share the cost of 9.6 Kbps links between them. The Ontario Centre for Large Scale Computation (OCLSC) then contributed the cost of doubling the line speed to 19.2 Kbps, at least among the founding members. Two Ontario centres of excellence, ITRC (Information Technology Research Centre) and ISTS (Institute of Space and Terrestrial Science) have since joined. In the new year, Guelph will join. A 56Kbps line to Ottawa will be installed to connect Carleton, NRC, BNR and potentially other Ottawa-based organizations. ONet provides TCP/IP connectivity

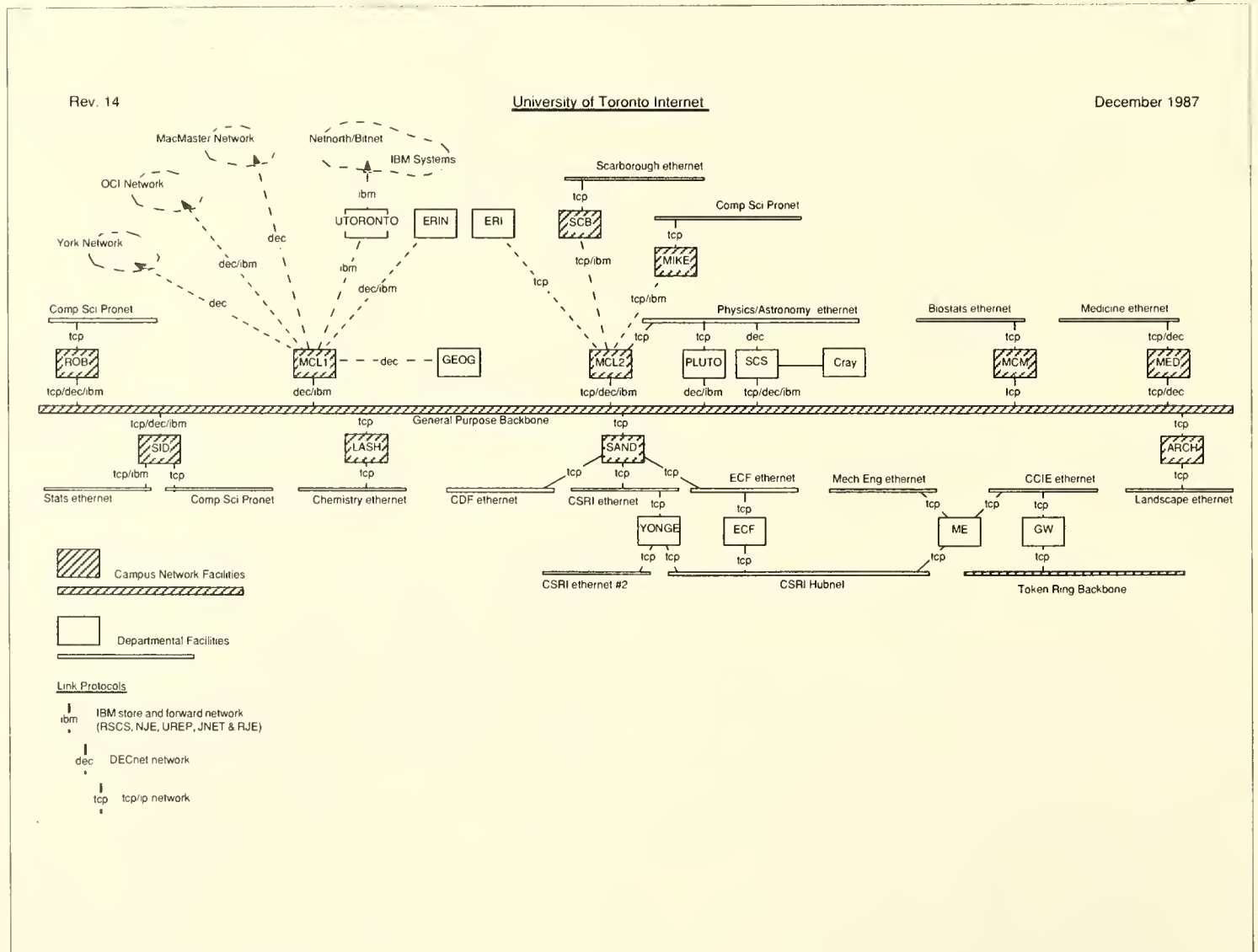
between the networks on each of the campuses. Though the routers can support DECNET traffic, addressing concerns make this less straightforward. While NetNorth connects these and many other campuses already, NetNorth is a batch-oriented, store and forward network. ONet however, allows a user on a machine on one campus to interactively log onto another machine on another campus, or via NSFnet and its connections, in the U.S. or Europe. Of course, the user must have an account on the target machine. This allows an unprecedented increase in the productivity of interaction with remote hosts, compared to NetNorth/BITNET. As more universities, government agencies, and centres of excellence join ONet, the additional funds will be used to add

more links, as appropriate, and to increase the bandwidth of existing ones. Since ONet makes use of the U of T connection to NSFnet at Cornell, \$125,000 of the cost of this link is contributed by ONet.

Proposed NRCnet National Network

For some time, the National Research Council of Canada (NRC) has been exploring the possibility of establishing a national, high-speed research network across Canada, linking regional networks of universities, industrial research centres and government agencies. UTCS has participated in many of the meetings investi-

Figure 1



gating this possibility. This past summer, NRC hired a consultant to prepare a "Request For Information" (RFI) to solicit information from suppliers or consortia of suppliers, to install, provide, and manage such a network. In December, UTCS in partnership with IBM and CNCP responded to the RFI with a comprehensive document outlining several bandwidth scenarios. Moreover, UTCS offered to provide the Network Operations Centre (NOC) function for the whole network, as well as software support and development of network monitoring and management tools. IBM Canada's contribution would be RT routers (up to 20) and software, and CNCP would provide the communications facilities, along with a contribution to offset the cost. UTCS' contribution would be the non "out-of-pocket" expenses associated with the NOC and the development. All partners' contributions are

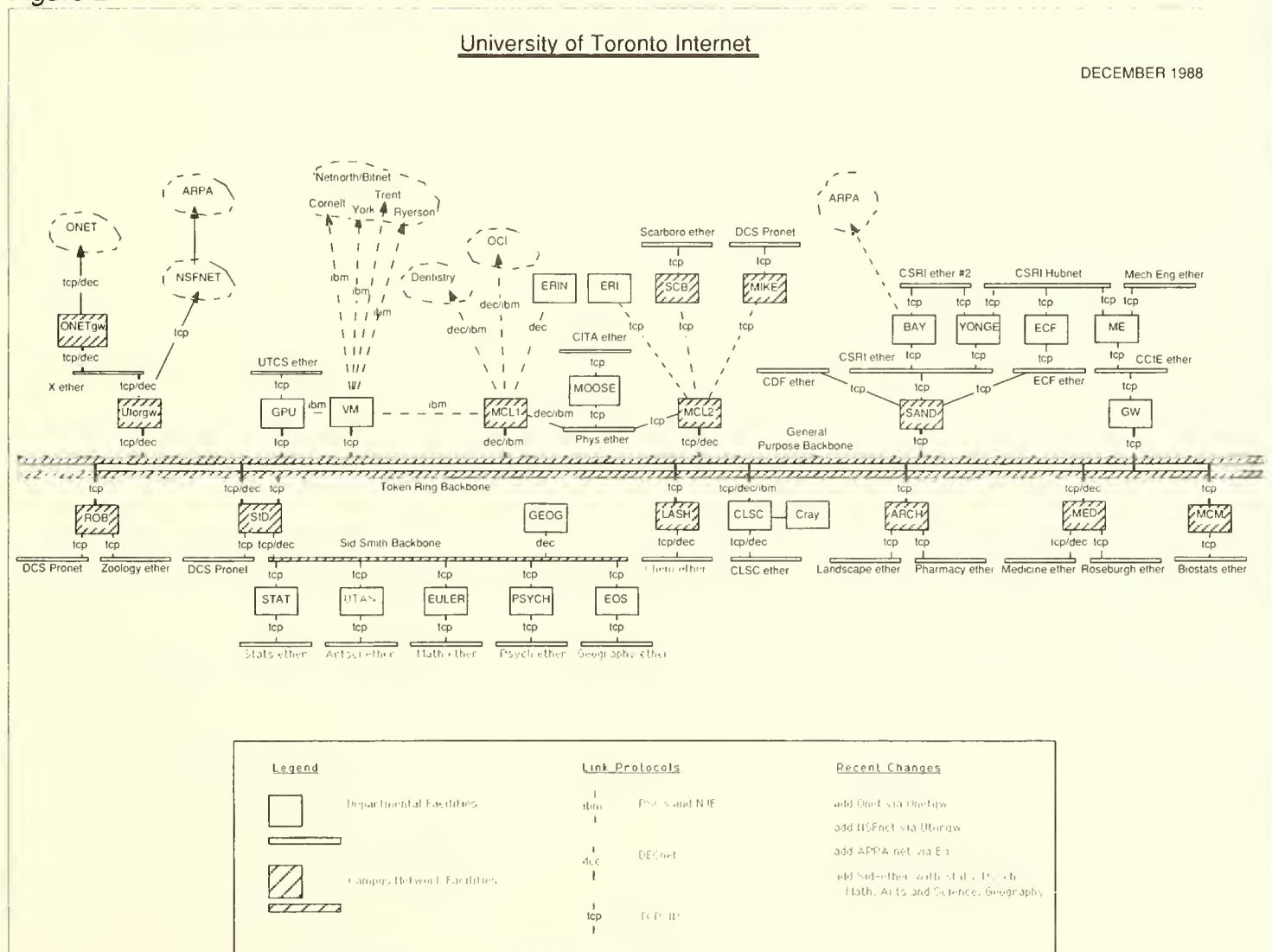
planned to phase-out over a three to five year time frame, such that the network is fully self-funding by the end of five years. Reaction to the RFI response is awaited.

U of T Internet

The networking environment within the University of Toronto has also changed significantly in 1988. Figures 1 (on previous page) and 2 show the configuration of the U of T Internet in December 1987 and 1988 respectively.

There has been considerable re-organization of existing networks as well as the addition of new ones. An "External Ethernet" was established to facilitate the connection

Figure 2



University of Toronto PACXNET

November 1988

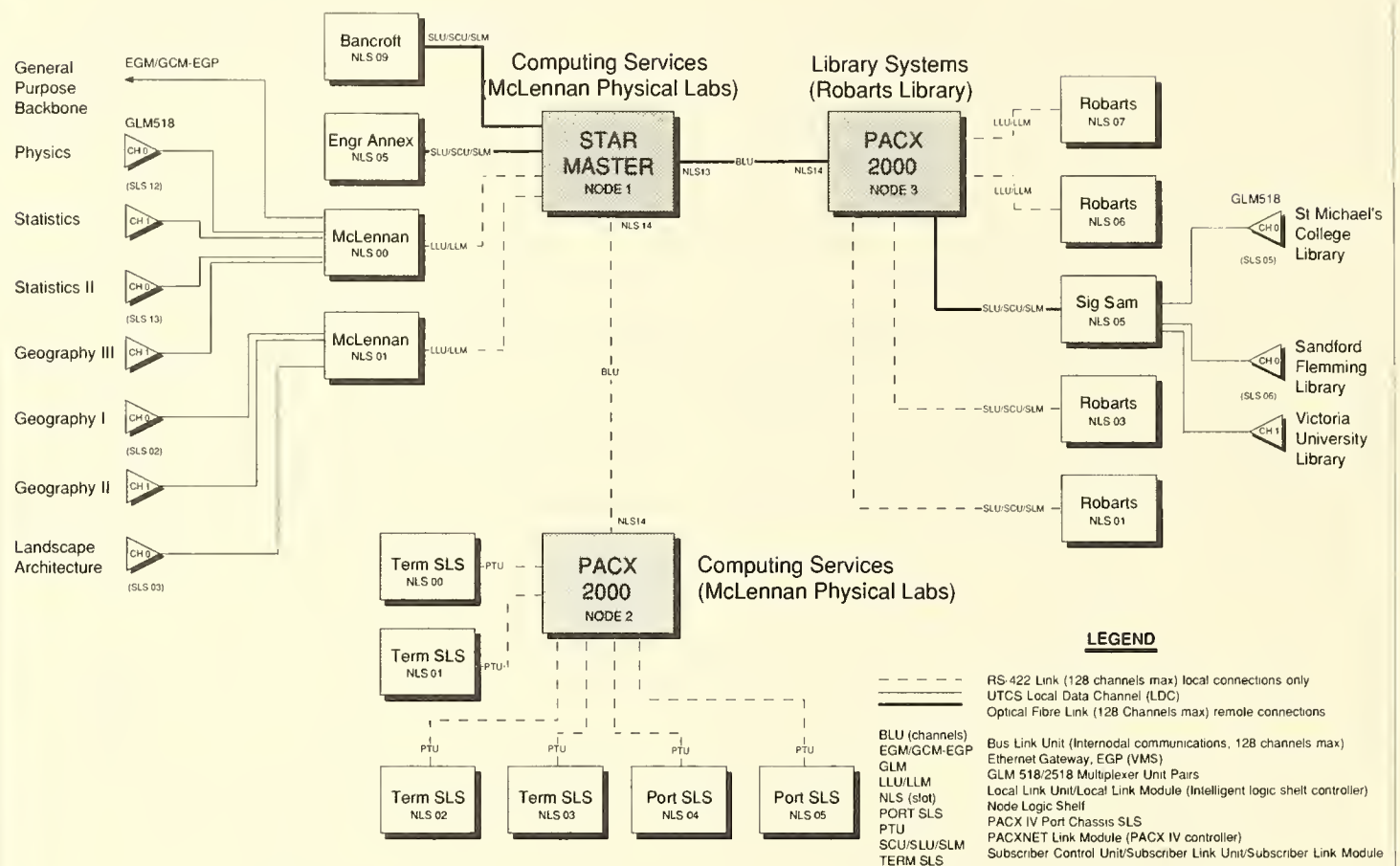


Figure 3

to the ONet universities via a cisco router. The gateway to this Ethernet also connects to the NSFnet at Cornell and thence to the ARPAnet. Several universities that had been previously connected to the "MCL1" nodal processor were moved to the ONet router. This freed up capacity on MCL1 to accommodate the addition of a connection to the Faculty of Dentistry. A local backbone was installed in Sidney Smith to connect the existing Statistics and Geography networks, as well as new ones for Math, Psychology, Arts, and Geography. Fibre optic cable was installed to connect Ethernets at Pharmacy and Industrial Engineering to existing nodal processors. A Zoology Ethernet was also connected to the General Purpose Backbone (GPB) via the nodal processor at Robarts Library.

OCLSC's configuration was modified to establish a separate Ethernet for the intimate connection of their front

end and graphics systems, while retaining direct access to the GPB. The Physics/Astronomy and CITA Ethernets were also reconfigured. The IBM VM machine "UTORONTO", which is being renamed to "VM.UTCS" was more intimately connected to the GPB via a 7170 DACU (Device Access Control Unit), rather than through MCL1. An UTCS Ethernet was established to connect UTCS' PC and AppleTalk networks to the Internet via the General Purpose UNIX machine (GPU) and to provide an Ethernet isolated from the backbone to permit safe testing of hardware and software, without impacting the other users of the Internet. The Token Ring Backbone was logically connected to the GPB via the nodal processor at Sidney Smith. This provided an alternate path for Mechanical Engineering and CCIE networks to reach the GPB, given the unreliability of their path through CSRI's Hubnet.

A 3174 controller was installed in the UTCS machine room to provide both 3270-type and Token Ring connectivity to UTCS' mainframe environments.

Figure 3 depicts the various components of the University's PACXnet, which uses the Terminal Switching Backbone (TSB) to interconnect local and remote logic shelves, which in turn connect to either clusters of terminals, or ports on host machines.

Micro Classroom Upgrade

The classroom in which MS-DOS based products are taught was re-equipped with eleven 386-based machines from AT&T, and a 3B2-400 file server, at such a sizeable discount from list price that it must be considered partly a grant from AT&T. The previous machines, IBM PC-XTs, were becoming inadequate in terms of memory capacity and power to run the new, more sophisticated packages. Also, the AT&T machines can run both MS-DOS and UNIX, which will be an advantage, given the growing

popularity of UNIX and applications that run under it. The displaced PC-XTs were reallocated to UTCS' Systems Group to replace dumb terminals, improving their support of academic and administrative mainframe systems.

4.2 UTCS Budget History

It may be instructive at this point to review the UTCS budget history since monetization in 1984/85. Figure 4 depicts UTCS' Gross Expense Budget (GEB), Net Expense Budget (NEB) and Income Target (IT) since the 1983/84 fiscal year. The IT graph represents real money income since 1984/85. Prior to that it was "funny money" or entitlements. The GEB and NEB were not exactly the same in 1983/84 because there was some real money income from research grants and commercial users. When monetization was implemented in 1984/85, the most obvious effect was the reduction in UTCS' NEB from around \$8 million to \$4 million. The difference between GEB and NEB was to come from the Income Target, which in that first year was more than \$3 million.

Figure 4

UTCS BUDGET HISTORY

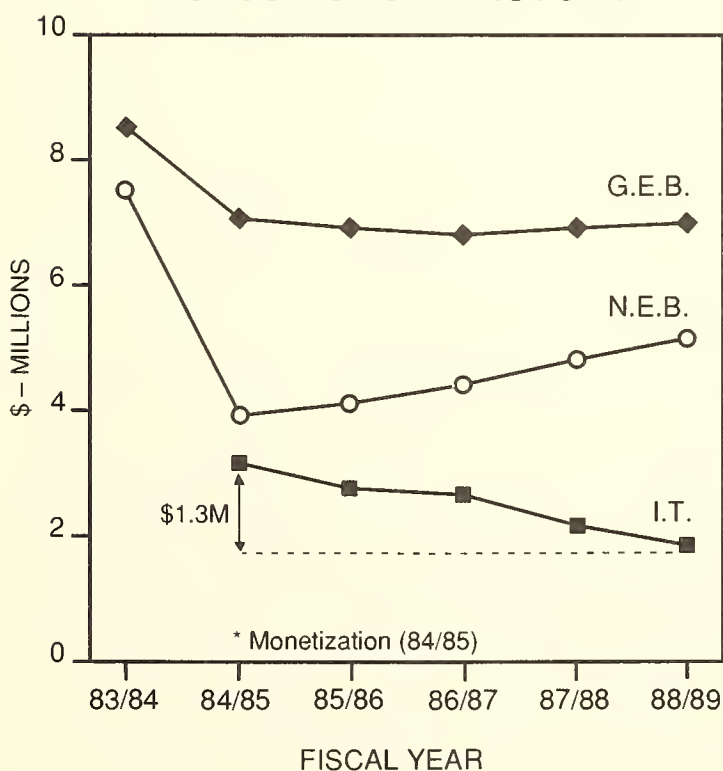
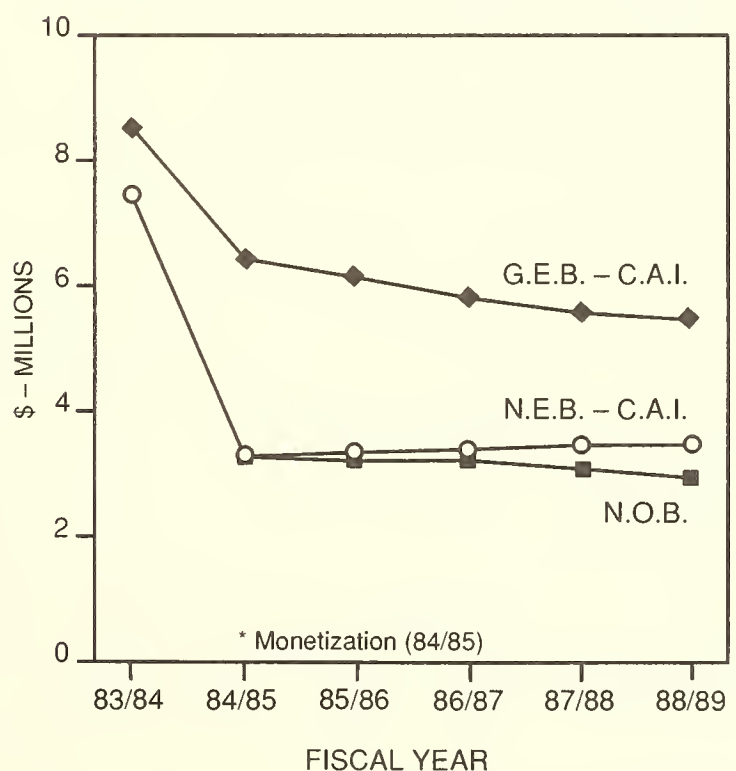


Figure 5

UTCS BUDGET HISTORY

(Adjusted for Salary Increases and Add-Backs)



In other words, the amount of funding received by UTCS from the University was cut in half, with the balance required to cover the GEB having to be earned from University or outside users, through income from machine-based services, consulting, and facility management arrangements. On top of the effects of monetization was a budget cut resulting in a very substantial reduction in real expenses, reflected by the decrease in the GEB. The mechanics of monetization were such that a part of UTCS' budget (about \$1.4 million worth) was distributed to the user community, based on an algorithm that considered previous use of entitlement funds. (This was done not by UTCS, but by the Office of the Vice-President, Research.) Users could then spend this real money in buying services from UTCS or anywhere else, so long as it was spent on computing.

After 1984/85, UTCS was able to reduce its expenses, with a corresponding reduction in Income Target, to the tune of about \$1.3 million over four years. Surprisingly, the NEB has consistently grown over the years, but the reduction in IT has kept the GEB almost constant. The solution lies in *Figure 5*.

In every fiscal year, there were several additions that tended to increase the annual budget; these were for salary increases and funds for specific projects or initiatives. *Figure 5* shows the same GEB and NEB as in *Figure 4*, but adjusted to remove the effect of the cumulative automatic salary increases (CAI) each year. In effect, the GEB-CAI and NEB-CAI graphs show the respective UTCS budgets with a constant salary level, that of 1984/85.

Furthermore, the Net Operating Budget (NOB) graph shows UTCS' budget without the addbacks that have occurred over the years for networking, administrative upgrades and software, etc. It shows a continuing decline in UTCS' "operating budget."

Moreover, if the administrative system were treated as a true facility management operation, all the costs associated with it — the hardware, software, maintenance, operations and support (which add up to over \$1 million) — would not appear in UTCS' Net Operating Budget at all. Instead, they would be a part of the Gross Expense Budget and be offset by income in the Income Target.

Thus, while gross budget figures appear to indicate a rise in UTCS' expense budgets, this is largely due to circumstances beyond our control (short of cutting more

staff), and UTCS continues to become more efficient in applying technological advances to reduce costs and improve productivity.

5. 1989/90 FINANCIAL PROJECTIONS

A balanced budget is projected for next year. Any new projects or initiatives would, of course, have to be explicitly funded. The upgrade of the administrative machine is an obvious example.

6. NETWORKING INITIATIVES

At its January meeting, the UTCS Board reviewed the various networking initiatives presented below and assigned two levels of priority. Items identified in the highest level of priority are marked with two asterisks (**). Items in the second, lower, level of priority are marked with one asterisk (*). Unmarked items were deemed to be at a third, even lower, level of priority for funding.

6.1 Backbone Interconnectivity

Connectivity among the diverse departments and divisions at this university is accomplished by the attachment of in-building Local Area Networks (LANs) to the inter-building backbones installed and operated by UTCS. At present, three distinct backbones are used to satisfy the connectivity needs. They are:

- General Purpose Backbone (GPB)
- Token Ring Backbone (TRB)
- Terminal Switching Backbone (TSB)

As technology advances and new facilities become available, these distinct backbones may begin to consolidate in the 1992 timeframe.

For the present and immediate future, it is desirable for all three backbones to interconnect, though even with interconnection, it may not always be possible to have identical functions on all backbones. Interconnectivity between the TSB and GPB is currently provided by a device donated by Gandalf. Unfortunately, it only

supports the DECNET mode of operation and not the more common TCP/IP mode. We have received requests from the Departments of Statistics and Physics to provide for TCP/IP-based traffic, as well as DECNET. This added connectivity will ease access to the FELIX library system for many researchers now using TCP/IP systems. The cost of this enhancement is \$16,000 for 16 concurrent terminal ports**.

6.2 Terminal Switching Backbone

The evolution of the GPB has identified an engineering anomaly with the Interlan terminal servers which were bought in 1984. These servers act somewhat as surrogate hosts to connect otherwise stand-alone terminals to remote hosts on the GPB. They now fail to handle broadcast packets correctly and, as a result, fairly regularly become inoperative. These units are no longer being manufactured and the company that produced them has been sold at least once. Repeated efforts to obtain a resolution to the problem from the supplier have been unsuccessful. In order that we may provide for full dynamic routing on the GPB, these servers must be replaced. It is proposed that they be replaced by devices called remote shelves, which are remote extensions of our Gandalf terminal switch on the TSB. Some of the necessary equipment has been donated by Gandalf for field trials that UTCS performed in previous fiscal years. Hence, it is not necessary to obtain new shelves. The anticipated cost for this replacement is \$8,500**.

It appears that, at least initially, the Earth Sciences Building will have a number of terminals which are not connected to local computers, but rather to the TSB via the PACX. A remote PACX shelf located in the building should handle the expected needs over the next fiscal year. This request is in addition to the requirement for a GPB nodal processor. The two devices satisfy different needs. The TSB shelf will be configured to handle the first year's needs only. A remote shelf can connect up to 128 physical terminals. The costs for this additional shelf will be \$18,500*.

6.3 Physical Infrastructure

The term "physical infrastructure" means the actual communications cabling and cable tray. The UTCS design philosophy is to incrementally connect increasing areas

of the campus with both optical fibre and some copper cable. These increases in coverage and connection have been occurring for a number of years as funds have permitted. The standards we established for the two types of cable are:

- 12 strand fibre cable
- 100 pair copper twisted pair

It is recognized that neither of these cable sizes are particularly large. They have, however, permitted the growth of a very effective campus networking environment. The actual costs for the installation of this infrastructure are dominated by labour charges and the cost of cable tray where that is needed, not by the cost of the cable itself. Cable tray is deemed necessary by Physical Plant.

During fiscal 1989/90, it is suggested that the following enhancements be made to the infrastructure. Both types of cable will be installed, as necessary:

- Add to the existing cable between McLennan Labs and Sidney Smith (\$25,000) **
- Cable from Sandford Fleming to Simcoe Hall (\$15,500)
- Cable from Simcoe Hall to the School of Graduate Studies (\$30,000)
- Re-organize the Sandford Fleming Hub (\$4,000)

The amount of cable needed to execute all the above plans is:

- 1.5 km of fibre (\$15,000)
- 500 m of copper twisted pair (\$3,000)

These estimates have been generated by UTCS and Physical Plant. The cost of cable tray is included, as necessary. The rationale for these infrastructure investments is further elaborated in the backbone expansion plans.

6.4 Token Ring Expansion

Both the Library Administration and the School of Graduate Studies have made a significant investment in token ring Local Area Networks within their buildings during fiscal year 1988/89. Connecting these local systems to the backbone environments would signifi-

cantly increase their utility. Fibre currently goes to the Medical Sciences, Robarts and Sigmund Samuel libraries. Hence, the requirement to achieve connectivity is only the provisioning of TRB nodal processors (IBM PC bridges) and repeaters. If the request for fibre to the SGS buildings is approved, they will require connection to the TRB. Repeaters and bridges will cost approximately \$25,000 for each site for a total of \$100,000. (The Robarts Library connection received second level priority*.)

6.5 General Backbone Expansion

The Departments of Chemical Engineering and Metallurgy have expressed the need for connection to the GPB. Since fibre already reaches their building, they only need to install a nodal processor, which both departments could share. A nodal processor and associated equipment for this requirement would cost \$25,000.

Last year's Annual Plan suggested that the Earth Sciences Complex would eventually require attachment to the GPB. Internal building wiring for data communications and the extension of fibre cable to wiring closets in the building should be completed this fiscal year. If intra-building networks are installed by the building occupants next year, then it may be appropriate to connect these internal networks to the GPB. If this requirement occurs during 1989/90, then a nodal processor will be required. The cost of this connection, as above, would be \$25,000.

7. INFORMATION CENTRE INITIATIVES

7.1 Hardware/Software Upgrade Fund

UTCS Board members noted that every year UTCS puts forward requests for funding of initiatives of one sort or another for the Information Centre. Because of the recurring nature, they felt that these items should not be considered as requests for one-time-only funding. UTCS should instead establish an internal fund to cover these annual expenses. Examples of such expenses are upgrades to existing hardware, seed money for software site licenses, new hardware that is gaining popularity in the university, and microcomputers specifically assigned to individual consultants for their day-to-day use.

7.2 Future Direction

Increasingly, information is being created, manipulated and presented with the aid of computers. As a result of this phenomenon, people have become increasingly aware of the need to have effective presentation of information. The most popular example of this is the layout and graphical design required for effective desktop publishing. Specifically, not only must the contentual information be provided, but it must be presented within the context of the medium. Another example may be found where a computer itself is used to present the information in a very effective manner, such as the Kanji HyperCard development at U of T.

In the past, UTCS has hired staff from non-computing disciplines, to bridge the chasm between area of application and computer technology. For example, we have regularly hired statisticians to assist in the support of computer-based statistical packages, and humanists to provide support in text-related areas.

To foster an awareness of this design issue, and to promote effective development of this style of application, we propose to hire a person skilled in the application of graphic design in computer programming. This person would assist users creating documents, forms, transparencies, and electronic publications. A full-time salary for a position of this calibre would be about \$40,000 annually. Members of the UTCS Board supported this request.

8. CENTRAL ADMINISTRATIVE SYSTEMS

8.1 Machine Replacement

When the existing administrative machine, an IBM 4381 R14, was last upgraded in November 1987, it was with the understanding that no further increase in capacity would be needed or requested until 1989/90. Monitoring of system usage has indeed indicated that the cpu will be out of capacity before May 1989, and projections of the capacity requirements of growth in existing applications and planned ones indicate that a machine of approximately two and a half times the power of the existing one would be needed to satisfy the administrative processing

requirements for three years, after which, this new machine would also be out of capacity. The existing cpu is popularly rated as having 6.0 Mips (Million instructions per second) of power. A replacement cpu would have to have about 15 Mips of capacity. This can be provided in various ways by several vendors, all of whose products are IBM-compatible. Compatibility with IBM is necessary to protect the University's investment in data base and application software development. To convert to a non-IBM software environment would entail an expenditure of millions of dollars and several years of effort.

The Technical Subcommittee of the Administrative Computing Committee reviewed various scenarios, presented by UTCS, for replacing the machine by a current or older generation machine from IBM, Amdahl, or NAS. After weighing the financial, technical, and practical ramifications of each alternative, a second-generation IBM machine was selected. This was based on the fact that the features offered by the current generation technology (ESA) were not deemed to be necessary within the three year timeframe, and could not justify the more than ten-fold increase in capital cost. Assuming the funding for the replacement is approved, an IBM 3081-K will be installed in May 1989. As part of the machine replacement, additional disk storage (5 Gigabytes) is necessary and included in the plan, as is the upgrading of the tape subsystem, described below.

8.2 Upgrading the Administrative Tape Subsystem

In the past two Annual Plans, UTCS has recommended the upgrading of the obsolete tape subsystem on the administrative machine, from 3420 tape reel technology, which is now 12 years old and even more obsolete, to the current 3480 tape cartridge system. Deteriorating reliability of the old tape drives, coupled with continuing growth in the size of the tape library and in disk storage requiring backup, force action. The old tape drives, with a data transfer rate of 0.47 megabytes (MB) per second, would create an intolerable bottleneck in an upgraded cpu when the newer 3480s transfer data at 3.0MB per second — a greater than six-fold increase. For these and other reasons (to do with floor space, media cost, storage space etc.), UTCS has included a tape subsystem upgrade as an integral part of the machine replacement plan. It is planned to be funded from the proceeds of the disposition of the existing cpu.

8.3 Increased Network Access to the Administrative System

Greatly increased access to the administrative system can be provided once the TSB and GPB are interconnected, as described in Section 6.1. This would allow users on departmental machines to be able to connect to our PACX, then to the 7171 protocol converter on the administrative machine. This mode of connection is subject, however, to concerns about both security and integrity of data. These concerns will need to be resolved before widespread access through this means can be permitted.

Plans are also underway to provide token ring access to the administrative system. Users who now have local token rings, such as the Robarts Library, Office of Academic Statistics and Records, and the School of Graduate Studies, and those who are considering them, as at 215 Huron, will be able to connect to the mainframe via the TRB and UTCS' 3174. As described in Sections 6.3 and 6.4, additional cabling, nodal processors, and repeaters are needed to connect some sites.

9. EMERGING SUPPORT AREAS

9.1 Data Library Service

A proposed "Data Library Service" (DLS) was described in last year's Plan. It was identified as an "emerging support area" then, and appears to be still emerging. This service was to be a co-operative project between the University of Toronto Library (UTL) and UTCS. Its intent was to provide ready access to machine-readable data, the initial collection of which was to be the approximately 260 tapes of census information, presently stored at UTCS. Additional acquisitions would depend on UTL's acquisition budget.

Since the access to data in the DLS was expected to be of a sporadic nature, in that a researcher would require infrequent extractions of a particular subset of available data, which would then be transferred to the user's own PC or departmental machine for further analysis, UTCS was prepared to assist users in formulating and effecting the initial extraction and transfer to the user's "home" system, rather than attempt to produce generalized, meaningful procedures and documentation on how users could do the extraction themselves.

UTCS was prepared to contribute the opportunity costs of the UTCS staff associated with this project (\$52,500), but funding was requested for out-of-pocket and facility management expenses (\$62,200). UTL was able to cover \$20,000 of the out-of-pocket expenses for data base software, and hired a support person, but the balance of \$42,200 for UTCS expenses remained unfunded. This year, the Board felt it was more appropriate for the UTL to request the funds on behalf of UTCS.

9.2 Academic Information Data Base System

UTL has submitted a proposal for the establishment of an Academic Information Data Base System (AIDBS), which would develop an electronic delivery system for the Toronto Health Sciences information network, provide electronic database searching of abstracts, indexes and reference tools via the campus network, and test a prototype electronic Canadian library of 1,000 texts. This system would require considerable data storage and computing resources, as well as intimate connection to the University's existing and developing communications networks. Should UTL be successful in establishing AIDBS, UTCS would be prepared to interface it to the various network environments, much as we have for FELIX, the catalogue system, as well as operate and support the system under a facility management agreement. If UTL is not successful, UTCS would be interested in exploring the gradual phasing-in of parts of AIDBS on existing facilities, to whatever level capacity and funding may permit.

9.3 Workplace Hazardous Material Information System

UTCS has been co-operating with the Office of Environmental Health and Safety (EHS) in exploring ways to provide access to Workplace Hazardous Material Information System (WHMIS) data to comply with the legislation regarding hazardous chemicals in the workplace that took effect last November. For initial compliance with the legislation, much of the WHMIS data is available on CD-ROM disks produced by the Canadian Centre for Occupational Health and Safety (CCOHS). EHS has distributed many CD-ROM readers to departments with large concentrations of potentially hazardous chemicals, such as Medicine, Chemical Engineering, Chemistry, and so on. This may not be a satisfactory long-term solution however, because the CD-ROMs distributed by CCOHS are not necessarily complete, in that some manufacturers refuse to provide machine readable data to CCOHS, preferring to sell their own CD-ROMs, and it may be impractical to provide the potentially large numbers of CD-ROM readers, and controlling PCs, to allow the necessary access points to satisfy the legislation. UTCS is exploring longer-term solutions, which may include a WHMIS server on the campus network, multiple network-accessible CD-ROM readers acting as servers, a centralized WHMIS data base on the administrative machine, or even direct access to a central WHMIS data base on a distant machine, such as at McMaster, via ONet. The functionality versus the cost-effectiveness of the various alternatives will be examined, in concert with EHS.

The State of 386s

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In July 1986, a small company called Advanced Logic Research released the first IBM PC-compatible based on the Intel 80386 microprocessor. Even though ALR did not ship any 80386s until late 1986, other manufacturers quickly followed ALR's lead with announcements of their own. That September, Compaq introduced the Deskpro 386, a 16 Megahertz (MHz) 80386 with one megabyte (MB) RAM and a 40MB hard disk. IBM followed suit in April of 1987, announcing their PS/2 line of machines, including the 80386-based Model 80. Since then, numerous manufacturers have announced and released 80386-based machines.

Who needs a 386? If you determine that you need one, which manufacturer do you go with? Which model do you buy? What are the differences between models? These and many other questions about 80386-based machines are being asked more often at the University of Toronto. We hope this article will help you determine if you really need a 386 and give you some idea about which model to buy.

How Fast Can it Go?

With the current state of software, very few people *must* buy a 386 in order to do their computing. However, this does not mean that you

don't *need* a 386, or that one wouldn't make your computing life easier.

In the DOS world, an 80286 or 80386 chip is treated by the operating system as an 8088 because these more advanced microprocessors are downwardly compatible with the original 8088. DOS itself, and about 95% of DOS software, does not take advantage of any of the additional features provided by the 80286 and 80386 microprocessors. However, these chips are driven by faster clocks and thus perform individual instructions in less time than the 8088. So, the first reason that you may have for buying an 80386-based machine is its speed.

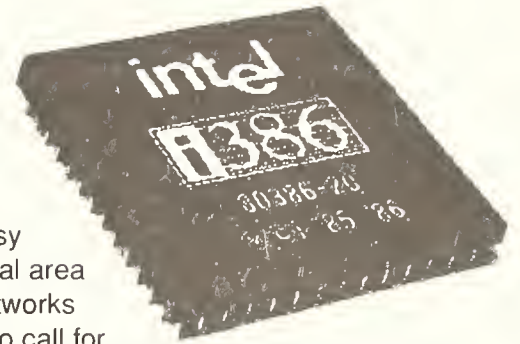
How much faster is an 80386-based machine than the original IBM PC? Benchmark tests show that an 8MHz 80286 is approximately 4 times faster than a 4.77MHz 8088, and that a 16MHz 80386-based machine is almost twice as fast as the 80286. Of course, these figures only indicate the *minimum* speed increases obtained on the faster machines — the actual speed increase is greater because of the enhanced features of the chips.

Which types of programs require blazing speed? Some examples include numerical analysis programs, large database programs, complex graphics programs, and any other programs that process large amounts of data. File servers for

busy local area networks also call for the enhanced processing power of machines based on these chips.

Crystal Balls, Anyone?

Another reason to buy a 386 is to provide for the future. Some programs available today *require* an 80386-based machine (Microsoft Windows/386, Paradox 386, and DESQview 386, to name a few), and more will be released, to be sure. Most of these programs take advantage of the additional features of the 80386 in order to provide a multi-tasking environment or to extend the amount of memory that a program may address. For example, the recently announced Release 3 of Lotus 1-2-3 will require an 80286- or 80386-based machine. As more of these types of programs appear on the market, 8088-based machines (and even 80286-based machines) may not have the computing power or the capability to run these programs. Many software vendors now recommend that their high-end software be run on 80286- or 80386-based machines, claiming that you would be disappointed with the performance on an 8088 and implying that new versions of the software may *require* them.



Furthermore, OS/2, the multi-tasking operating system for IBM PCs and compatibles, will not run on 8088-based micros. The program requires at least an 80286 microprocessor because it takes advantage of the extended features of this chip. As OS/2 grows and more applications are written to take full advantage of it, even 80286-based micros will start to run out of computing power. This may be another reason you might have for choosing an 80386-based machine.

Which 386 is Which?

So now you've decided to buy a 386, but as you browse the stores and the available literature, you realize that there are numerous models and options, even from individual manufacturers (a quick count of offerings in the latest *PC Magazine* found no less than 37 systems from 21 manufacturers). What do you do?

Generally, there are three types of 80386-based micros available today, with more coming soon. At the low end are machines powered by the slowest of the 80386 chips, running at a mere 16MHz. In the middle of the range are the machines powered by 20MHz chips. The high end of the 80386 market features the 25MHz machines, complete with hardware RAM caches, huge-capacity hard disks, lots of memory, and high price tags.

The 16MHz machines, typically referred to as the workhorse 386s, are the slowest and least expensive of the group. Almost every manufacturer of PC compatibles has a

16MHz 386 in their product line, available in a variety of RAM and hard disk configurations. If you are satisfied with the performance of the software on your AT now, but are thinking of using more of the leading-edge programs in the future, these entry-level 386s may be for you.

The 20MHz 386s perform at least 25% faster than the 16MHz variety simply because of their faster clock speed. However, some manufacturers add a hardware RAM cache, further increasing the performance of the machines.

Cash or Cache!

A cache is a small amount (usually 32KB or 64KB) of very fast RAM controlled by a cache controller. When the microprocessor requests data from main memory, the contents of the RAM cache are checked first. If the requested information is found in the cache, it can be accessed by the microprocessor quickly. If it is not found, the slower main memory must be accessed. Thus, the RAM cache allows the manufacturer to increase the performance of the machines without a major cost increase.

Who are the 20MHz machines designed for? Eight months ago, these machines were the ultimate in performance, but now they exist in a grey area of the market, thanks to the availability of 25MHz machines. Professional desktop publishers will find the price/performance ratio of these machines to be satisfactory, as will users of CAD packages, statistical and numerical analysis packages, programs with large databases, and other power-hungry programs.

Speed Limits: Slow Down, Please!

Now, most larger manufacturers produce 25MHz machines. The ultimate in technology, standard features on these machines usually include hardware static RAM caches, large fast hard disks, 2MB or more of RAM, VGA video, and other leading-edge features. But these machines do not come cheap. After adding a tape backup system, extra RAM, a math coprocessor, a VGA color monitor, and the software to take advantage of all this power, these systems cost \$15,000 or more, not including printers, plotters, graphics tablets, and other I/O devices.

The market for these machines is not large, and that is one reason why the machines are so expensive. Users of large CAD packages, mainframe-type database programs, calculation-intensive programs, and multi-tasking operating systems are about the only people who can push these machines to their full potential.

Just as 20MHz machines were surpassed by 25MHz machines, these may soon become the entry-level 386s. Intel (the manufacturer of the 80386 microprocessor) has already announced a 33MHz chip, with quantity delivery expected this spring. And the 80486, an upgrade to the 80386, will start shipping in the fourth quarter of this year. Machines built around this chip are expected to be announced early next year. So, hold on to your hats. We may be doing things with micros in 1990 that we can't even begin to imagine today!

Computer Networks

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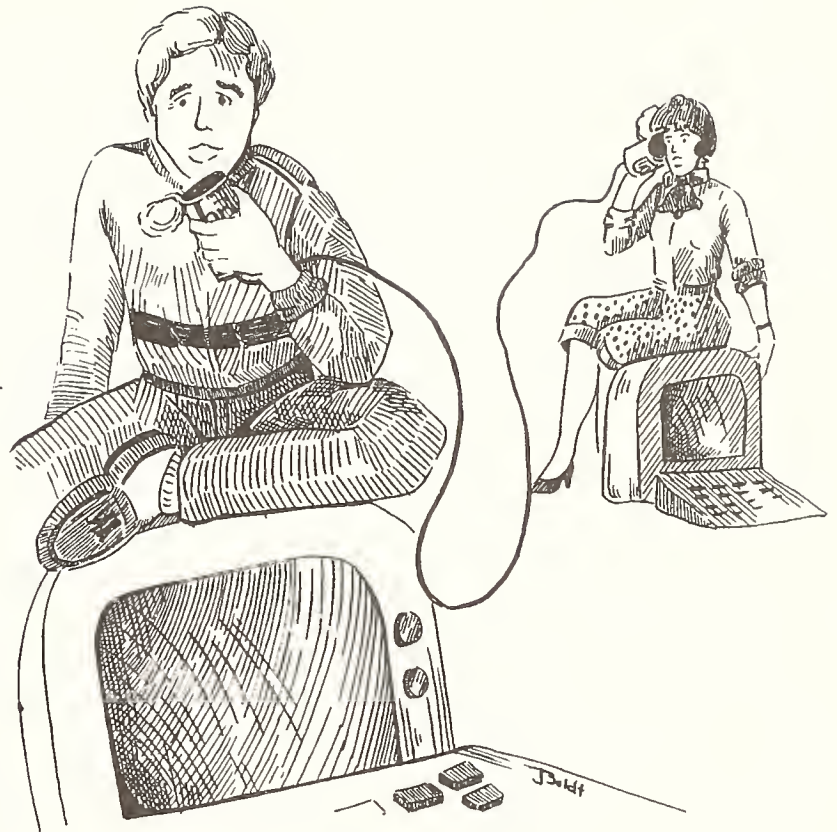
A department on campus recently purchased Macintosh computers for its administrators. The department required relatively high-quality laser printers, but at a cost of \$5000 per printer, each person could not get one. The department opted to install only two laser printers and connect them to each computer via a network. This is easy to do because every Mac comes with the hardware and software needed to participate on an AppleTalk network. By buying laser printers that are equipped for AppleTalk, and by connecting the appropriate wiring between them and the Macs, it became possible to share the printers.

Back in 1969, the American Defense Advanced Research Projects Agency (DARPA) found that it was funding expensive computers that were being underutilized. To encourage sharing of time on these computers, it established the ARPAnet network, by which large computers were connected to each other. Researchers with appropriate hardware, software, and physical wiring to the network could then get access to these otherwise idle computers, even if the computers were at distant locations.

Computer networks come in all sizes, from departmental networks that connect a few Macs in an office, to campus-wide networks that connect hundreds of machines, to networks that connect the universi-

ties of Western nations. Networks are frequently created to permit sharing of information or equipment in a more efficient or economical manner. The result, however, frequently goes beyond these goals, altering the very method of interaction with the computer and even between people.

In the case of the department with the AppleTalk network, the administrators began to use their network for more than printer sharing. To begin with, they found that documents and inter-office memos can be sent electronically between Macs on the network. In the case of ARPAnet, researchers used the ability to send mail and documents electronically to exchange ideas with their colleagues across the continent and, eventually, around the globe. Researchers found that they could work on papers jointly by sharing their contributions on a daily basis. Using electronic mail, they were able to build electronic bulletin boards and, through these, hold the equivalent of forums and conferences. As these cases demonstrate, the work being done on the computer slowly began to change because of the networks.



Networks vary in the kind of functions they provide. The NetNorth network (created and used by Canadian universities) does not provide as many services as does the ARPAnet, mentioned above. Nevertheless, in order to understand computer networks and their impact on modern university computing, it is useful to talk about some of the possible services a network can provide:

Electronic Mail

Electronic mail, or e-mail for short, allows you to send messages to users on other computers. Frequently, the message looks similar to an office memo, with a "To" line, "Subject" line, and "CC" lines at the top, and a text area below. Some e-

mail systems go a step further and permit sending diagrams or other graphics. Some record and transmit words spoken into a microphone, allowing users to send and receive voice-messages. E-mail was once available only to users of mainframe or mini computers. However, it is now possible for users of desktop workstations and personal computers to send and receive e-mail without using a larger computer.

File Transfer

File transfer permits you to get files from and/or send files to another computer. If you have used Kermit to copy a file from a computer to your personal computer, then you have used a simple two-computer "network." The Internet networks, which include ARPAnet and connect thousands of computers in hundreds of institutions, use FTP (file transfer protocol) to list, send, and receive files. Using FTP, a researcher at this university can copy files at very high speed to or from a colleague's computer at almost any other university in North America. On the NetNorth/BITNET/EARN networks, SENDFILE serves a similar purpose, though it only permits files to be sent.

How does e-mail differ from file transfer? E-mail is actually a special case of file transfer where the format, that is, the office memo appearance, has been formally agreed on by system administrators. Most computer systems provide tools to compose and send e-mail, and your recipient's computer will probably recognize it as e-mail and permit it to be read by your recipient. On the other hand, when you send a file, it could be data, a program, a spreadsheet, or any other type of file.

Network File Systems

Using a network file system, a disk, or part of a disk, located on one computer can be made to look as if it is located on one or several other computers. This is also known as a remote file system, a remote virtual disk system, or a distributed file system. Using a network file system such as that provided by Novell or VINES, many departments at this university buy one or two personal computers with large hard disks to act as "file servers." Connected to these are groups of personal computers that have no hard disks, but are set up to act as if they have one or more hard disks. Some of these "imaginary" or virtual hard disks can be shared among all the personal computers. This might be used, for example, to have everyone run the same copy of dBASE or WordPerfect. This type of sharing can save disk space and maintenance time because only one central copy of a program need be installed. (Of course, you must still pay for multiple copies of the application, although many vendors now offer special discounts for network versions of shared applications.) Virtual disks can also be set up so that each user can have a personal disk.

In the UTCS Information Centre, a network file system provided by a Sun TOPS network is used to connect an Apple Macintosh to an IBM PC. From the Mac, the hard disk on the PC looks like a Mac disk, and vice-versa. This network is used to move files back and forth between the Mac and PC environments. Using similar software, we have also connected our Macs to our UNIX minicomputers. With this setup, a Mac user can access all UNIX files as if they were on a Mac hard disk.

Across campus, many departments are saving money by buying diskless UNIX workstations and then using Sun's NFS (Network File System) and file servers. The file servers are usually larger UNIX machines with large hard disks.

How does file transfer compare with network file systems? With file transfer, if a copy of a file is required at two locations, it must use up disk space on both computers; with a network file system, disk space is only used for one copy. With file transfer, however, a file moves across the network only once; with a network file system, if a file is repeatedly used across a network, it must be transmitted each time. Using a network can thus affect performance because it is often slower to move files over the network than it is to get the files directly from a hard disk. It may also be more expensive to use a network, if network usage must be paid for.

For the computer user, network file systems tend to be easier to use than file transfer. With file transfer, commands must be learned in order to send files through the network. With network file systems, however, the illusion of a local disk is often so complete that no new commands need be learned — the computer user only needs to know how to handle the application files. Of course, because additional information must be sent through the network in order to create the illusion of local disks, the network overhead is generally higher.

Deciding if a network file system or file transfer is most appropriate in a given situation depends on the type of computer user, the size of the files involved, the frequency of access, the speed of the network, as well as a number of other factors.

Network Database Systems

In a basic network database, a single database can be shared across a network by multiple users. One way to implement this type of shared database is to use a network file system. For example, a dBASE database of chemical formulae on your personal computer could be set up to be read, by your colleagues, across a network such as Novell or VINES. However, there are several problems with this approach. First of all, you could not allow your colleagues to update this database. If multiple dBASE programs try to simultaneously update the same database while unaware of the activities of each other, a scrambled database will result. Another problem is that it may be inefficient to have dBASE read the database across the network as it searches for records.

An alternative approach is to have a "database server" on the network. A user would specify search criteria on his personal computer, workstation, or larger machine, which would send the criteria or query to the database server via the network. The server, a computer with the only copy of the database and a database program, then initiates the search using its own local resources. The results of the search, the records matching the search criteria, are then sent back to the user's computer. This approach results in less network activity because only queries and their results travel across the network. As well, because only one database program is actually accessing the database, it is safe to give many users the ability to do updates.

In some situations, a distributed database is better suited than the

centralized database server discussed above. For example, to create a database of all research journals and books in Canada, you might use multiple database servers, placing one in every Canadian university. When a query comes in, the database servers would work together to provide the right answer, even if this requires pulling records from the servers of multiple institutions.

Database servers and distributed databases are still not widely used. In fact, there are few examples of networked university databases. However, vendors have been promising database packages which support SQL, a standardized database query language. It is hoped that SQL, which stands for Structured Query Language and is a standard way for computers to send queries to a database server, will lead to more networked databases.

Remote Execution

Remote execution allows you to run a program on a remote computer. This can be useful when you require the resources of a specialized computer, such as the CRAY X-MP. Remote execution could also be used to distribute the load of work. For example, your personal computer might hand some work to another machine, which might otherwise be idle.

Often, you do not need to learn how to use another computer in order to use remote execution. For example, a Mac user may not want to learn how to use a CRAY X-MP, though she may need to run programs on the CRAY. Remote execution facilities are available that permit the networked Mac user to request remote execution of a program on a networked CRAY.

One of the most common remote execution examples on campus is the use of the UNIX remote shell facility. An UNIX user, using a computer connected to the campus network, can run any UNIX command on another UNIX computer connected to the network. (The user also needs authorization to use both computers.)

Remote login

Remote login permits you to log into and use another computer on the network. A program on your own computer sends the characters you type to the remote computer and returns information from that computer to your screen. People who have used ProComm, Kermit, or Red Ryder from their personal computers are familiar with dialing up and using a remote computer. This type of activity is an example of a simple, two-computer "network." A program called TELNET, available for practically every computer including IBM PCs, Apple Macintoshes, workstations, and mini and mainframe computers, allows people with access to the appropriate campus network to log into other computers on the network, anywhere in the world. In this way, the potential exists for a user to log into perhaps thousands of computers. For example, using TELNET on a Mac that is connected to the University of Toronto's campus network, it is possible to log into a computer at Stanford University.

There are several reasons why you might want to use remote login. In some cases, remote login to a computer from a personal computer or workstation is a cheap alternative to buying a dumb terminal. Also, using the network may be cheaper than running a dedicated line from the terminal or computer to the

remote computer. Third, because some computer users need access to specialized computers, remote login is useful because it permits easy access to these machines.

Furthermore, remote access may save equipment costs. For example, some departments are using Macintosh II computers as file and mail servers on their AppleTalk networks. The cost of a graphics card and screen, usually about \$2000, can be saved by having maintenance on the Mac II done using a product called Timbuktu. Timbuktu permits remote login to the screenless Mac II (i.e., the file server) from another Macintosh on the AppleTalk network. Timbuktu can also be used for instructional or other purposes between two Macintoshes that have screens.

Printer Sharing

Printer sharing allows access to remote printers as if they were directly connected to your computer, even if the printer is connected to another computer. For example, a dot matrix printer may be connected to one personal computer in your department. Using a network such as Novell, VINES, or IBM LAN, you can make the printer seem as if it is directly connected to your personal computer. In actual fact, your print files are being sent from your PC to the computer with the printer. This computer is sometimes called a "print server."

Some printers can be attached directly to a network. For example, an Apple LaserWriter can be hooked to an AppleTalk network because the LaserWriter contains the necessary software and hardware for AppleTalk communication. Macs on the AppleTalk network all have the appearance of direct access to the

LaserWriter. However, when printing is requested, the Mac actually uses the AppleTalk network to send the file to the LaserWriter.

How is remote printing related to other network services already discussed? In many cases, remote printing is really a special case of file transfer. The file to be printed is transferred from your computer to the "print server." In other cases, as when "intelligent" printers such as the LaserWriter are involved, remote printing is comparable to remote execution. When a Macintosh needs to print, it actually sends the printing request, in the form of a language called PostScript, to the LaserWriter for remote execution.

Other Equipment Sharing

Engineering departments across Canada are saving money by using e-mail in order to share equipment needed for manufacturing. Making a small number of prototypical VLSI (Very Large Scale Integration) electronic chips is very expensive. Engineering departments with VLSI design courses cut costs by e-mailing designs to a single facility at Queens University. There a small number of chips are produced, each chip containing all the designs turned in. Each university then uses only that part of the chip that it designed. By combining all the designs on one chip, the cost of producing the chip can be substantially lowered.

On a smaller scale, a department might save money by sharing equipment such as modems. This sharing will work as long as the equipment is not so heavily in demand that some people can't get the opportunity to use it. A modem

such as the Shiva NetModem can be connected to an AppleTalk network. Then, any one Mac on the network can use it at a given time.

As these examples show, not only printers can be shared across a network. From pen plotters to automated lathes, many possibilities exist for sharing equipment. Equipment sharing is really another special case of file transfer and remote execution. If another university has an automated lathe that you wish to use remotely, you can view that lathe simply as another specialized box on the network. Similarly, the CRAY X-MP is another box with a speciality, as is a LaserWriter, which has printing as its speciality.

The New View of Computing

At one time, large computers were the focus of computing, while printers, terminals, disks, and so on were looked upon as mere peripherals. But networks have changed the perspective on computing. The emerging view focuses on "computing boxes," each of which performs specialized functions, that are interconnected through a network to create the overall computer system. The individual user interacts with the box sitting on his desk. This, in turn, uses the network connection — a single cable — to negotiate among other boxes.

Computer Networks and TCP/IP

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Computer communications can be compared to human communications. Just as humans must speak the same language in order to understand each other well, so computers must use the same protocols in order to exchange information. When connected computers can successfully exchange information by using compatible hardware and software protocols, a network exists. Unfortunately, the problem of diverse and dissimilar human languages also has an analogy in the world of computer communications — there are many different computer network protocols, and most of them are incompatible.

This incompatibility exists because many computer vendors have their own network protocols. IBM has SNA, Digital has DECNET, Prime has PRIMENET, and Wang has WangNet. In the personal computer arena, things are even more confusing because there are so many more protocols. Apple AppleTalk, Corvus Omninet PC/NOS, IBM PC LAN, Novel NetWare, Torus Systems Tapestry, 3Com 3+Share, Sun TOPS, and Banyan Systems VINES are just some of the network types, all of which have some representation on campus.

Not only are different network protocols largely incompatible, many network protocols don't offer the same network services. For

example, one might offer remote execution while another might not. Furthermore, even if two network protocols offer the same service, they may do it in completely different ways. For example, Sun's NFS (network file system) moves files a byte at a time from the file server as the files are accessed by the client. IBM AFS, on the other hand, created with a different design philosophy, sends entire files from the file server to the client when they are first accessed. Incompatibility is so widespread that even the features and format of a service as simple as e-mail are often dissimilar.

In some cases, the incompatibility of network protocols in the marketplace may not matter, as in a corporation that uses a single vendor for all its computing needs. In most places, however, especially in universities, incompatibility can pose a real problem. If you work on a Digital VAX computer connected through DECNET, it would be frustrating to be unable to exchange e-mail or share resources with your colleague at another university who happens to use an IBM mainframe. An even greater problem exists where departments on campus are using more than one network protocol. This causes problems when, for example, someone in the department on an IBM PC LAN network wants to access the printer connected to the UNIX machine, which is on a different type of network.

Gateways to Better Communications

One way to solve this interconnection problem is to build "gateways." For example, UTCS runs a gateway on campus for moving e-mail between the campus DECNET and other campus networks. There is also an e-mail gateway between the campus RSCS network and other campus networks. (RSCS is an IBM protocol used for the NetNorth/BITNET/EARN network.) Because an e-mail gateway is dedicated exclusively to e-mail service, services such as file transfer, remote execution, and so on need their own gateways.

However, because so many network protocols are used in universities, building gateways to bridge every possible combination of protocols would quickly get out of hand. If one "standard" protocol existed, this might provide a solution to the problem. Then we could either use the standard protocol or build a gateway between our vendors' proprietary protocols and the standard protocol. Currently, the closest thing to a standard protocol is the Internet protocol suite, more commonly known as TCP/IP. The development of TCP/IP was initiated by DARPA (Defense Advanced Research Projects Agency) in the early 1970s, when its system administrators realized that the

American military needed to interconnect various networks. Today, TCP/IP is so widespread, especially within North American research networks, that it is a *de facto* standard.

Several hundred networks using the TCP/IP protocol suite are now interconnected. In the United States, these include the following: ARPAnet, which connects research institutions funded by American Defense contracts; MILnet, the American Military network which used to be part of ARPAnet; CSNET, which connects North American Computer Science departments; and NSFNet, which connects American National Science Foundation supercomputers. These networks cover wide areas and are in turn connected to many regional networks, some of which cover multiple States. The regional networks, in turn, are connected to campus networks, which are connected to departmental networks.

In Canada, a national TCP/IP research network has yet to be created, though the National Research Council (NRC) is now negotiating for the establishment of NRNet (National Research Network). NRNet is envisaged as a backbone network connecting regional networks. It is felt that a Canadian TCP/IP network would encourage research in Canada as well as prevent the redundancy of Canadian universities running individual network connections to the U.S. in order to use American networks. A few TCP/IP regional networks already exist in Canada. In Ontario

we have ONet, which is only a few months old. It currently connects the U of T and six universities (soon to be seven or eight), and is expanding to include two provincial centres of excellence, at least two government departments, and four industrial members. A cluster of new members in Ottawa will soon be attached via a very fast Ottawa/Toronto link.

TCP/IP networks have existed for many years at the University of Toronto. Departments such as Computer Science and Engineering were using TCP/IP back in the days when it was largely an experimental protocol. For the last five years, UTCS has been building and maintaining a TCP/IP campus backbone network. Quite a few departments with a departmental TCP/IP network connect to the overall campus network. Fortunately for the computer user, these hundreds of networks (campus and international) all appear as a single network. This collection of interconnected TCP/IP networks is frequently referred to as the "Internet."

Network interconnectivity will permit people to use a number of services, including one called TELNET. If, when using TCP/IP, you issue the command:

telnet watmath.waterloo.ca

you will be establishing a remote login to the "watmath" machine at the University of Waterloo. Behind the scenes, invisible to you, your departmental network is passing information to the campus backbone network, which, in turn, is talking to

the ONet network, which is talking to Waterloo's network.

TCP/IP is easy to use and has many things going for it. Thanks to the many TCP/IP network interconnections, a researcher at this university can use TCP/IP to reach most of the research institutions of North America. TCP/IP is available for most types of computers, so there is a good possibility that you can communicate and share resources with your research colleagues even if they use a different computer than yours. Also, because this and other university communities have years of experience using TCP/IP, there is a lot of expertise to draw on when problems arise.

TCP/IP is available in several ways. In some cases, there are public domain implementations. In other cases, vendors offer competing TCP/IP products. TCP/IP is used over many different forms of physical media. On campus, TCP/IP networks use optical fibre as well as different types of cables. TCP/IP can even be run over radio connections.

What is the future of TCP/IP?

The ISO (International Standards Organization) is working on a new set of protocols called OSI, which stands for "Open Systems Interconnect." The experience gained by developing TCP/IP and other network protocols is being used to develop this new suite of protocols.

Will ISO/OSI replace TCP/IP? Some authorities running TCP/IP-based networks say it will, while other people are more cautious in their predictions. Dennis Ferguson of Mechanical Engineering at U of T, whose opinions on networking futures are widely respected, thinks we will not see a quick migration to OSI, even though many people talk about it happening. He believes that people will be running both OSI and TCP/IP on the same networks and machines for a long time. He does concede that OSI will eventually replace TCP/IP, but only as applications running under OSI become more fully featured. He explains that there is some confusion in the industry — people are holding off purchasing applications for TCP/IP because they fear that OSI will take over and render their software obsolete. Dennis contends that people need not fear, for TCP/IP will be useful for as long as it fills the needs. This means that if applications for TCP/IP fit your needs now, then TCP/IP is useful to you — you don't need OSI. As he points out to those waiting for OSI, it took ten years to get TCP/IP right, and OSI is a lot more complex.

Gateways from TCP/IP to other Network Protocols

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Because the TCP/IP network protocol suite is a *de facto* standard, people using a different network protocol would like to know how to connect to TCP/IP. In many cases, it is possible to gateway some services from your network to TCP/IP and thus enjoy interconnectivity across network protocols.

An example of this form of gateway is the DECNET e-mail bridge run by UTCS. This bridge, set up by the Communications and Technical Support (CTS) group at UTCS, gateways e-mail between the Digital DECNET campus network, used by Digital VAX computers, and the campus TCP/IP network. Another example is an RSCS-to-TCP/IP e-mail gateway that is run by the UTCS Systems Group. (RSCS is the network protocol used by the NetNorth/BITNET/EARN network.) In another case, the Information Centre and CTS are currently working on an AppleTalk-to-TCP/IP e-mail gateway. Using this gateway and an e-mail package called QuickMail, Macintosh users will be able to communicate, via their AppleTalk network, with TCP/IP networks and, via the TCP/IP networks, with DECNET and RSCS networks.

The result of these e-mail gateways is that e-mail can be exchanged between any machines served by AppleTalk, DECNET, RSCS, or TCP/IP. It also means that e-mail originating from or directed to computers on any of these networks can use the international network, regardless of the protocol used by the international network. Note, however, that only e-mail is exchanged across the gateways. Other network services, such as file transfer, remote login, and so on, are not supported.

If you are not running a TCP/IP protocol network but you need to connect to one, it is possible to run TCP/IP over your existing network. For example, UTCS has an AppleTalk network of Apple Macintosh personal computers. CTS has installed a box between the campus TCP/IP network and our AppleTalk system. This box, called a Kinetics FastPath, permits us to run TCP/IP protocols over AppleTalk protocols. By using a public domain TCP/IP TELNET and FTP (file transfer protocol — written by the American National Center for Supercomputing Applications), packets of information are sent out by AppleTalk using TCP/IP protocols. The FastPath box removes the information being sent to the TCP/IP network from the AppleTalk network and puts this information on the TCP/IP network. The reverse process occurs when information is directed from the TCP/IP network to a Mac on AppleTalk. Using TCP/IP over AppleTalk provides full access to the TCP/IP network through the existing AppleTalk network.

Comparing NetNorth and ONet

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In the past few years, *ComputerNews* has featured a number of articles describing NetNorth/BITNET/EARN. With Dr. Warren Jackson's announcement last month in *ComputerNews* that the campus network is now connected to ONet, some people might be wondering how the two networks compare. BITNET, which, according to legend, stands for "Because Its There NETwork," was created in 1981. It is a network that connects, primarily, the computing centres of American universities. BITNET was modelled on one of the oldest and biggest computer networks, Vnet, which is IBM's internal network.

BITNET, like Vnet before it, uses the IBM RSCS protocol. RSCS, which stands for Remote Spooling Communications Subsystem, is the IBM mainframe operating system (VM) protocol for printing remotely. It was designed so that a mainframe user printing a file could route it through the RSCS network to the preferred printer. It was also designed so that files produced by card readers (which read punch cards — cardboard cards with holes punched in them to denote data) could be routed to the appropriate computer.

By using the ability of RSCS to send printer files and card files through the network, BITNET permits file transfer between IBM mainframes. The IBM VM/CMS SENDFILE command is used to break up a file so it can be sent as a card file, and

the RDRLIST and RECEIVE commands are used to put the file back together. IBM also supplies a command called NOTE for sending electronic mail (e-mail). Finally, a command called TELL is supplied to send one-line messages to the screen of someone currently logged into a computer on the RSCS network.

When NetNorth, originally called OUNet (Ontario Universities Network), was created in 1984, TCP/IP, RSCS, and other protocols were available. One of the early goals of NetNorth was to connect to American research networks, and both RSCS (e.g., BITNET) and TCP/IP (e.g., ARPAnet) were available for making these connections. However, only RSCS was considered at the time.

NetNorth Based on RSCS

NetNorth was modelled on BITNET. Money was scarce, and the need for a researchers' computer network was not yet well established in Canada. Many of the computing centres at universities involved in organizing NetNorth had IBM mainframes that could be pressed into service at little additional cost. As well, RSCS works well over slow communication lines, and slow lines (i.e., 2400 baud) had been chosen for use between the universities in order to limit costs.

NetNorth was created using RSCS network protocols. NetNorth connected to BITNET, the American research network based on RSCS, and EARN, BITNET's EuroAsian equivalent, and has served Canadian researchers quite well.

RSCS Versus TCP/IP

How does an RSCS network like NetNorth/BITNET/EARN differ from TCP/IP-based networks such as ONet, NYsernet, ARPAnet, NSFNet, and so on? At a lower level, one basic difference is that RSCS is a "store and forward" network technology whereas TCP/IP is not. For example, when you send e-mail to Carleton University from the University of Toronto machine called UTORVM, the file queues up and is then transmitted to a machine at McGill University called MCGILL1. At MCGILL1, the file is stored and queued to wait for a line to a machine at Queen's University called QUEENS, and then forwarded. Similarly, QUEENS stores the file, queues it, and then forwards it to a machine called UOTTAWA. UOTTAWA stores and then forwards it to a machine called CARLETON, the intended destination.

A TCP/IP network sending the same file, on the other hand, would break it up into little pieces called datagrams, which are sometimes incorrectly

called packets. Each of these is usually only a few hundred bytes in size. The individual datagrams are routed through the network or networks until they arrive at their destination. Then they are reassembled in their correct order to form the final file.

At a higher level, there are more basic differences, and these are important to users. RSCS networks only provide e-mail and file transfer. Because of the store and forward nature of RSCS networks, they cannot provide services such as remote login, remote execution in real time, and other similar services. Furthermore, because RSCS is a proprietary protocol, any additional services to be provided through RSCS would almost certainly have to be provided by IBM.

TCP/IP-based networks are frequently used for e-mail, file transfer,

remote login, remote execution, network file systems, and so on. Because TCP/IP is an open protocol, that is, the specifications are available to anyone, and because it is a protocol that the research community continues to develop, new network services are being added. In fact, unlike RSCS, it is fairly easy for an applications programmer to write software that uses the underlying layers of TCP/IP to build new services. For example, a time synchronization protocol, used to synchronize the time clocks of computers across the network, was recently written and is now supplied with some UNIX systems.

What is the future of RSCS and TCP/IP networks in Canada? Certain universities are so distant from other universities that the faster communications lines necessary for TCP/IP are prohibitively expensive. Other universities have had a slow

growth of network usage and cannot justify the added expense of a faster line. These universities are likely to want to use NetNorth's RSCS-based technology for a while longer.

Other universities, especially the larger universities in larger population centers, are connecting to the TCP/IP international networks. Thus, they are paying for parallel TCP/IP and RSCS network connections. A package called BITNET II (which is supposed to be available this fall) permits RSCS protocols to run over a TCP/IP network. Using this, universities connecting to TCP/IP-based regional networks would not need to pay for parallel lines. BITNET II will also permit an orderly migration for universities moving from RSCS protocols to TCP/IP protocols. The ONet network is currently looking at getting BITNET II, since in Ontario we are still running parallel lines for NetNorth and ONet.

dBASE IV Update Seminar

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We have scheduled dBASE IV Update Seminars for dBASE III Plus users who would like to see the new features of dBASE IV. These seminars will highlight the enhancements and additions to the commands and functions of dBASE.

We are offering these seminars because so many new features have

been included with dBASE IV. A completely new user interface has been added, along with full query-by-example and SQL capability, a fully-featured applications generator, and hundreds of improvements in the dBASE command language. These changes represent major advances in the ease-of-use and functionality of dBASE.

The dates and times of the seminars are as follows:

- Thursday, April 20, 1989
10:00-12:00 noon
- Wednesday, May 3, 1989
2:00-4:00 p.m.

To find out about registration procedures and to book a spot in one of these seminars, please call Irene Rosiecki at 978-4565.

Microcomputer Courses

Irene Rosiecki
rosiecki@vm.uts.utoronto.ca

The following list shows courses scheduled from April through to June only, though more courses are scheduled for July and August. To find out about registration procedures and to book a place in any of these courses, please contact Irene Rosiecki at 978-4565.

Introduction to dBASE III Plus

June 26-30, 1989
9:00-12:00 noon

dBASE IV for the Beginner

May 29-June 2, 1989
2:00-5:00 p.m.

dBASE IV Update Seminars

April 20, 1989
10:00-12:00 noon

May 3, 1989
2:00-4:00 p.m.

Desktop Publishing Seminar

April 18, 1989
10:00-3:00 p.m.

Introduction to DOS

June 19-23, 1989
9:00-11:00 a.m.

Electronic Mail Seminar

May 24, 1989
2:00-3:30 p.m.

HyperCard Seminar

June 19-20, 1989
10:00-12:00 noon

Microsoft Word on the Macintosh

May 15-19, 1989
1:00-5:00 (May 15)
1:00-4:00 (May 16-19)

Introduction to PageMaker 3.0

April 24-28, 1989
12:00-3:00 (April 24)
1:00-3:00 (April 25-28)

ProComm Communications Seminar

May 24, 1989
12:00-2:00 p.m.

Introduction to Lotus 1-2-3

May 15-19, 1989
2:00-5:00 p.m.

Introduction to SAS on the PC

April 24-28, 1989
3:00-5:00 p.m.

June 5-9, 1989
1:00-3:00 p.m.

Intermediate Applications of SAS on the PC

June 19-23, 1989
2:00-5:00 p.m.

Introduction to WordPerfect, Version 4.2

April 24-28, 1989
12:00-3:00 p.m.

Introduction to WordPerfect, Version 5.0

May 15-19, 1989
9:00-12:00 noon

Advanced WordPerfect, Version 5.0

June 5-9, 1989
9:00-11:00 a.m.

June 19-23, 1989
11:00-1:00 p.m.

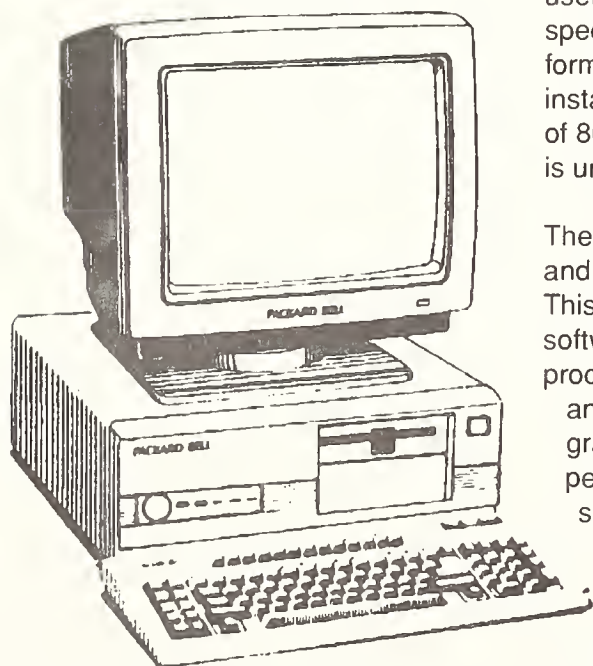
Review: Commodore PC40-III and Packard Bell PACKMATE 12

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Two new AT-compatible machines have come to market in recent months. Both come with a small footprint, 1 megabyte(MB) of RAM, a 40MB hard disk, VGA graphics, and MS-DOS 3.3, and both operate at 12MHz and offer excellent performance at an inexpensive price.

Commodore PC40-III

The Commodore PC40-III is a speedy machine. Its most striking feature is the speed of its 40MB hard disk. We rate it at 20 milliseconds(ms) average access time with a data transfer rate of 580 kilobytes/second (KB/sec), which is simply outstanding performance. It



Packard Bell PACKMATE 12

is fast enough for a 1-1 interleave and has produced no drive errors in the two months we have had the machine.

The PC40 comes with 25-pin serial and parallel ports, a VGA video port with clearly labelled DIP switches at the rear of the unit, and a Commodore mouse port. Note that a VGA-compatible monitor is necessary, such as VGA mono, VGA colour, or multisync. The built-in graphics adapter can emulate CGA, HGC, EGA, or VGA. The standard configuration is for a VGA mono monitor; we reviewed it with a VGA colour monitor (TTX).

Documentation comes in the form of an Operations Guide and an MS-DOS manual. The guide is very useful, providing necessary technical specifications as well as enough information for the beginning user. For instance, its discussion of which kind of 80287 you could use in the PC40 is uncommonly lucid.

The PC40 worked with all software and hardware that we tried on it. This includes desktop publishing software such as PageMaker, word-processing programs such as Word and WordPerfect, and many graphics packages. It also worked perfectly well with our DEST scanner and IBM Token Ring Network adapter.

The PC40 does sacrifice a few things to keep the price down. Memory, as in other Com-

modores, excludes parity checking. The processor uses one wait state. The motherboard is partially covered by the drive bay chassis, making it difficult to get at. However, the usual jumpers that you might need to access are exposed. There are only three 16-bit slots and one 8-bit slot available, although all can take full-length cards and all are empty: the serial port, parallel port, graphics adapter, and floppy-disk controller are all built-in on the motherboard, and the hard disk controller sits on the drive itself.

With the PC40, Commodore has pushed the AT to its limits. It is quite fast and represents excellent value for the price. With mouse and VGA monochrome monitor, it costs between \$2800 and \$3000 at the University of Toronto Computer Shop. It's an excellent buy.

Packard Bell PACKMATE 12

We have had the Packard Bell PACKMATE 12 for a much shorter review period than the PC-40. While we have not fully tested it, preliminary findings indicate that it slightly outperforms the PC-40 in CPU speed but has a slower hard disk speed. We rate the Miniscribe 8051 hard disk at 28 ms, with a data transfer rate of almost 400 KB/sec. It is possible to reduce the interleave to provide even better performance.

It comes with one parallel, one 9-pin serial, and one 25-pin serial port. The serial port worked well with ProComm at 9600 baud and with LapLink at 115 kilobaud. A bonus is the additional 9-to-25 pin adapter included with the machine.

The PACKMATE 12 uses zero wait states, allows for 2MB of RAM on the motherboard, and offers one proprietary slot for memory expansion for a total of up to 8MB of memory meeting the LIM 4.0 Expanded Memory Specification. In all, there are six 16-bit slots and two 8-bit slots in addition to the proprie-

tary slot, with the serial/parallel card, disk controller, and VGA adapter taking up one slot each. All software and hardware tested thus far has worked well, including an IBM Token Ring board running PC LAN.

The PACKMATE 12, bundled with IMSI Publisher, a combination word-processing and desktop publishing package, currently sells for \$2900 with a monochrome VGA monitor and \$3200 with VGA colour. It is noteworthy that Packard Bell's reputation on campus has undergone changes recently. Their machines are widely used on

campus, and until late 1988, the company flourished here. Their ATs, while bulky, are well respected; ours still continues to function well. Late last year, however, delivery problems arose, causing frustration for many parties. Packard Bell, under the leadership of a new vice-president of sales, is now endeavouring to reestablish itself and promises to avoid the delivery and quality control problems it experienced last year. The PACKMATE 12 promotion is, we hope, a step in the right direction.

LOCKIT: Affordable PC Security

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If your PC with a hard disk is accessible to more than one person, you may be interested in LOCKIT I, II, and III, security devices from Security Microsystems Consultants.

LOCKIT I is the first level of defense. It prevents you from accessing a hard disk unless the correct password is entered when the system is booted. Booting from the floppy drive won't defeat the security scheme — you will get an "invalid drive specification" message if you try to access the hard disk. A second feature allows you to blank and lock the keyboard and screen while a program or application is running, preventing even a <Ctrl-Alt-Del> input sequence from affecting operations. The password must be entered to restore normal operation. We found this feature worked well when tested with several common software packages.

LOCKIT I, which uses a combination of hardware and software security, is not only easy to install and use, it also seems to be impregnable — we couldn't find a way to defeat it. Even a program such as Norton Utilities cannot be used against LOCKIT I — if you don't know the password, you cannot access the hard disk. This package would be ideal in a public setting where only authorized users are allowed to access a PC's hard disk.

If you would like to allocate private subdirectories on the hard disk for each potential user, you can use LOCKIT II. This allows each user to create a private password for access to a hidden subdirectory. While stopping short of encryption, this seems to provide stringent security in a multiuser environment.

LOCKIT III can be used to limit access to specific applications on the disk. You act as the LOCKIT administrator to assign passwords and access controls to each user and generate individual menus of authorized applications. LOCKIT III can also be used as a batch menu generator for people unfamiliar with (or unhappy with) the DOS interface. These features, together with the ability to create a secure system and the availability of optional proprietary encryption/decryption, make this an useful package.

LOCKIT works on most hard disk systems. If you're concerned about unauthorized access, consider giving it a try. Each of the three packages comes with a short manual and sells for about \$80. LOCKIT I, II, and III are available from Torco Systems. Call Lee Rector at (416) 285-6644.

PRO-C Application Generator

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PRO-C is a C source code generator. Using a menu-driven approach, you can build data structures, screens, menus, and reports, complete with context-sensitive Help, to form applications. While this sounds similar to the front ends and report generators of many database packages, the extra benefit is that in each of the above cases, C source code is generated. This not only allows you to modify the source code itself, it also makes the application more portable. PRO-C has versions for MS-DOS, QNX, XENIX, and UNIX. Thus, if appropri-

ately licensed, code can be easily moved from a machine running DOS to a MicroVAX or Sun.

In any of the environments, a C compiler is necessary to compile the source. Once compiled, the application can be handed to a user, who will not need to have a compiler or PRO-C. PRO-C is thus aimed at applications developers. In addition, it can be used for teaching C itself.

Interfaces to Btrieve, ISAM, and dBASE III Plus, along with the ability to define interfaces to other pack-

ages, allow construction of complete applications. The Btrieve run-time module is included.

UTCS will have a copy of PRO-C for MS-DOS for evaluation in April. If you use Turbo C, Microsoft C, WATCOM C, or Zortech C, you might want to try it out. Please call 978-HELP to arrange an appointment. PRO-C for MS-DOS is available from Vestronix in Waterloo for \$405. Call Paul Valeriote at 1-800-265-2682.

Harvard Graphics Now at UTCS

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Harvard Graphics Version 2.1, one of the most popular graphics programs for IBM PC and compatible microcomputers, is now installed in the UTCS Microcomputer Lab. It can be used to create 35MM slides (using the UTCS Polaroid Palette slide maker), printed graphs (laser print on paper or transparencies), or video slide shows.

The program is an easy-to-use menu-oriented system. It works well with or without a mouse and supports a wide variety of hardware, such as HP LaserJet printers, film recorders (slide makers), plotters, and video adapters and displays.

Harvard Graphics makes it very easy for you to produce word, line, bar,

pie, and other types of charts. Data for the charts can be entered directly into the program or can be imported from plain text (ASCII) or Lotus 1-2-3 files. The program can be configured for two printers, one film recorder, and one plotter at the same time. For example, you may select an inexpensive colour dot-matrix printer, an high-quality black and white laser printer, a plotter (for colour drawings without large shaded areas), and a film recorder (for high-quality 35MM slides). Once created, your graphs and charts can be produced on any of these devices. The program can also export in many forms. For example, you can export charts and graphs in EPS (Encapsulated PostScript) or HPGL (Hewlett

Packard Graphics Language) form for use in a desktop publishing package.

As well as being easy to use, Harvard is also powerful. The menu system is almost self explanatory — everything you need is available on one of the menus. This easy but powerful concept applies to what you create as well. Harvard makes it very easy to create a basic chart, then gives you the power to customize the chart as you need.

For more information or to arrange to see Harvard Graphics, contact Terry Jones at 978-4924.

SAS/PC News

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SAS/PC Renewal

We would like to remind all our SAS/PC licensees that the current license for the product expires on June 30, 1989. If you want to continue using SAS/PC, you must renew the license. That is the "bad news." The good news is that, thanks to the large number of licensees, the individual costs are going down. We expect the following fee schedule to apply from July 1, 1989:

Basic package (base + STAT + GRAPH):	\$70
SAS/FSP	\$10
SAS/IML	\$20

Basic package for networks (for each machine)	\$35
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We will send letters to all licensees in the near future to detail the renewal procedure.

Release 6.03 Updates

We have received an update for the SAS/GRAPH module. The update fixes certain problems with the GPLOT procedure and with some existing drivers (such as the driver for the Hercules card). In addition, the update provides new drivers for the devices listed in *Table 1*.

Calcomp ColorMaster thermal printer
Computer Graphics Metafile (CGM), black and white
Computer Graphics Metafile (CGM), color
QMS Colorgrafix 100 printer (CGM format)
QMS Colorgrafix 100 printer; A size paper (CGM format)
Hewlett Packard DeskJet Printer (75 DPI)
Hewlett Packard DeskJet Printer (100 DPI)
Hewlett Packard DeskJet Printer (150 DPI)
Hewlett Packard DeskJet Printer (300 DPI)
Imagen 2308 printer, non-quoted binary output
Panasonic KX-P1080i dot matrix printer
Panasonic KX-P1091i dot matrix printer
QMS ColorScript 100 printer (PostScript)
Texas Instruments 855 printer
Encapsulated PostScript files — for producing thin lines

The SAS Institute has also sent us an important update to the SAS/STAT module. This update contains revisions of two procedures — PROC GLM and PROC LIFEREG — as well as five procedures new to Release 6.03 of SAS/STAT: PROC CORRESP, PROC LIFETEST, PROC PRINQUAL, PROC PROBIT, and PROC TRANSREG. These procedures are described in SAS Technical Report: P-179, which you can order through UTCS. If you are only interested in PROC LIFETEST, you can use the Version 5 SAS/STAT manual.

If you obtained your license for SAS/PC before March 20, 1989 and want to add the updates for SAS/GRAPH

and/or SAS/STAT to your system, please call 978-4990 to arrange to borrow the update diskettes.

New SAS/PC module: SAS/ETS (Econometrics and Time Series)

We have received a beta version of the newest SAS/PC module: SAS/ETS. If you are interested in trying it out, you are welcome to get it from UTCS at no cost. The module will work until the renewal deadline. All we ask is that you share with us your

Table 1

impressions of the software — we will send users' comments to the SAS Institute.

New SAS/PC module: SAS/OR (Operations Research)

SAS Institute will soon provide a SAS/OR module for microcomputers. Whether UTCS will obtain the license for this module depends on the number of interested users. If you are interested in acquiring this

module, please call Andrzej Pindor at the number given below.

SAS/ASSIST: Menu-Driven Interface to SAS/PC

Licensed users of SAS/PC can obtain a SAS/ASSIST module from us free of charge. SAS/ASSIST is a component product of base SAS software that is designed to give quick and easy access to many features of the SAS System.

However, to be able to use SAS/ASSIST, you must have at least 1MB of expanded memory (LIM 3.0 EMS or later).

Who To Contact

If you are having problems running SAS/GRAPH that might relate to the above mentioned fixes, or if you need any of the new drivers or are interested in acquiring any of the new modules, please contact Andrzej Pindor at 978-5045.

SAS under UNIX

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Since 1988, the SAS system has been available for several computers operating under UNIX, specifically the Sun (SunOS 4.0) and HP (HP-UX) workstations. Because of the large number of these machines at the University of Toronto (Suns in particular), UTCS has acquired a site license for SAS under UNIX, and we are ready to distribute it to interested parties. As usual with SAS, this is a yearly license and it covers the following single-user workstations:

HP 9000/318; HP 9000/320; HP 9000/319;

Sun 3/50 series; Sun 3/60 series; Sun 3/100 series; Sun 3/200 series

The following machines are considered to be multiuser machines and are counted, for the purpose of the license fee, as 10 workstations each:

HP 9000/330; HP 9000/350; HP 9000/360; HP 9000/370;

Sun 3/100 Sunserver; Sun 3/200 Sunserver

The license period begins July 1, 1989 and we expect the following fees to apply:

Base SAS and SAS/STAT:
\$100 for single-user machines
\$400 for multiuser machines

Additional modules (SAS/GRAPH, SAS/FSP, and SAS/IML):

\$50 each for single-user machines
\$200 each for multiuser machines

For people wanting to install SAS as soon as possible, that is, in April or May, the prices will be 50% of the prices given above, and of course, the license has to be renewed on July 1, 1989.

Please note that large HP machines not listed above (such as the HP 9000/850) are not covered by the site license. SAS Institute will only license machines of this size individually.

Please call Andrzej Pindor at 978-5045 if you are interested in installing SAS on your UNIX machine.

Features of SAS/IML on a Microcomputer

Bill Fehlner

Overview

As mentioned in the October 1988 issue of *ComputerNews*, SAS/IML (Interactive Matrix Language) is now available as part of the University of Toronto site license for SAS/PC. Although IML is primarily a matrix manipulation language, it also has a graphics component and it interfaces quite well with other elements of the SAS system. This article is an introduction to some of the facilities available through IML.

For many years, the SAS system has included PROC MATRIX, the ancestor of the current PROC IML. PROC MATRIX had a number of the basic features of the prototype matrix language, APL, but because PROC MATRIX lacked some key elements, it easily frustrated programmers used to working in a richer environment. IML has overcome many of these limitations, and it is relatively easy to express matrices and parallel operations on matrices in a concise and natural form.

Matrix Language

Those readers who are familiar with matrix languages can skip the first two paragraphs in this section. One of the major benefits of a matrix language is the ability to quickly prototype an idea in a form very close to the way you think about the problem. Being interactive, it is easy to build a complex calculation one step at a time, checking each step for validity. Moreover, an unfamiliar

operator or function can be quickly tested in a number of situations to verify its correct behaviour.

Using a matrix language has parallels to programming for a supercomputer — you have to force yourself to think in different terms if you are to take advantage of the latent power of the language. In particular, a good matrix language such as IML allows you to replace most iterative (i.e., do loop) processes by one or more operations on matrices. This has benefits even for small matrices (e.g., 5 x 5) and provides enormous gains as the size of the matrices increase.

Two-dimensional ($n \times m$) matrices form the basis for computations in

IML. Vectors ($n \times 1$), scalars (1×1), and empty matrices (0×0) are special cases. Matrices can be assigned values directly or can be extracted from either a SAS dataset or a raw data set. New matrices can be built from one or more old matrices in many ways. A few examples are seen in *Table 1*.

There are many more arithmetic, comparison, and logical operators available. These are extended even further by functions for reshaping, matrix inquiry, reduction, linear algebra, and so on. Some examples are seen in *Table 2*.

All of the scalar functions available in a SAS DATA step can be accessed from within IML. In particular, values

Table 1

M1 M2	concatenate horizontally
M3//M4	concatenate vertically
M5 + M6	add element by element
M7 < M8	compare element by element
M1 # M6	multiply element by element
M3 * M5	matrix multiplication
M7[,5]	extract the fifth column of M7 as a column vector
M8[+,]	calculate the column sums of M8 as a row vector
M9'	transpose the matrix

Table 2

REPEAT(M5,2,3)	combine six copies of M5, two vertically and three horizontally
NROW(M7)	determine the number of rows in M7
SSQ(M3)	calculate the sum of squares of the elements of M3
INV(M6)	calculate the inverse of a square matrix M6

of various probability distributions or their inverses (e.g., the non-central F distribution) are directly accessible. This collection of operators and functions provides a basis for expressing algorithms in a very concise form.

An Example

For example, in a recent project it was necessary to orthogonalize a matrix, X, constructed from powers of a variable. The following code creates a column vector of variable values and column vectors representing its powers:

```
X1 = {1,2,6,11,26,51,76,101} ;  
X2 = X1 # X1 ;  
X3 = X1 # X2 ;  
X4 = X2 # X2 ;
```

A column of the orthogonal matrix, Z, can be computed from the columns already obtained and the next power vector. For example, if Z3 is the column generated from X3, we add Z3 to Z with:

```
Z = Z||Z3 ;
```

Then we can calculate the column Z4 and add it using:

```
Z4 = (I(8) - Z*INV(Z'*Z)*Z')*X4 ;  
Z = Z||Z4 ;
```

where I(8) is the identity matrix, INV(...) computes the matrix inverse, and Z' is the transpose of Z. These few lines of code replicate almost exactly the algorithm as expressed in a statistics text.

Modules and Their Storage

Modules are a named collection of SAS/IML statements that are compiled together and that can then be referenced by name at any later point in an IML session. They have some analogy to subroutines and provide an excellent way to capture code that you have developed and tested in an interactive session. It is as simple as recalling the code that just ran successfully, adding a START and a FINISH statement to the code, and submitting it.

Version 6.03 of SAS/IML has added the ability to create libraries of these modules. This means that the time-consuming compile need only be done once. A later session can begin by naming the module library and loading the modules of interest into the workspace. If a better version of a module is created, it can be added to the library at any time. It is possible to create an entire application in a module library. Then you need only supply the input data as vectors and/or matrices and call the application.

Interface With Other Components of SAS

The interface between IML and base SAS has several components. One or more existing SAS data sets can be opened for access from within IML, and new SAS data sets can be

created. It is possible to convert all or part of a SAS data set into a matrix in IML with a single IML READ command. Conversely, a SAS data set can be created directly from an IML matrix. Individual records in a SAS data set can be altered, or additional records can be appended.

As was mentioned above, all of the scalar functions available in a SAS data step are accessible from IML.

IML includes a facility to build new IML statements from within IML. This provides considerable flexibility in building applications for which some items (e.g., an input data set name) are known only at run-time. Operating system commands, as well as display manager commands, can be issued from within IML. In generating text that is to be later executed, both the character manipulation functions in IML and the facilities of the macro language may be used.

Interface With Graphics

IML has a set of graphics commands that can be used to create graphics images one piece at a time. IML graphics operators depend on components of SAS/GRAPH, and the latter must be installed in order to use these operators. The graphics commands also require considerable memory, so working in DOS with EMS or in an UNIX environment is recommended.

The graphics commands allow you to build one or more graphics segments and to display them in one or more viewports. These viewports are predefined areas on the graphics device and, with care, one can overlay segments, mask certain areas, and change the scale of any segment. Graphics segments produced by SAS/GRAPH procedures and stored in a graphics catalog can also be displayed in a viewport. Segments produced within IML can also be stored in a catalog.

IML graphics is not a "paint" style graphics package. Although you have the benefit of the rapid display of each segment as it is being built, you must work in terms of Cartesian coordinate systems. In some of our initial tests of the graphics commands, we found it difficult at times to combine segments in exactly the form desired.

The other features of IML are much more important than the graphics commands, although the presence of these commands offers the promise of better things to come. In the meantime, there may well be applications that can profit from having a graphics interface immediately available from within IML.

Limitations

There are a number of limitations that can make working with SAS/IML frustrating at times. Some of these are directly related to the hardware

platform being used, while other limitations are a result of design decisions.

The key limitation is the maximum number of elements in a matrix. For MS-DOS, this number is 4095 numeric elements or 32000 character elements. For UNIX-based systems, the maximum number of either type of element is increased to 32765. Many problems can be stated in terms of matrices of this size, but we have found that intermediate constructs may exceed the limit. It is sometimes possible to choose an alternative solution that uses smaller intermediate matrices, but at other times, we are forced to do a large calculation in several segments. This takes a lot of time, both because the IML program is further from the natural expression of the solution, and because more checking is required to validate the results.

Another limitation is that arrays can have only two dimensions. Once you begin to think in terms of matrix operations instead of do loops, intermediate constructs involving a third dimension will sometimes allow efficient removal of yet another level of looping. There are also mathematical situations that are most naturally expressed in arrays of three or more dimensions.

On a PC with DOS, the 640 kilobyte (KB) limit imposed by the operating system means that the IML workspace is limited to about 100KB.

This becomes a problem when you work with a large number of IML modules at the same time. You can work around this problem in several ways. Modules can be stored in a library until needed, then copied into the workspace and dropped when no longer required. Alternatively, the addition of one megabyte of expanded memory (EMS) increases the maximum workspace size to 350KB. You can also decide to make the jump to a UNIX system — then the workspace size is limited only by the size of your machine, not by the operating system.

An Invitation

SAS/IML can be added to an existing license for SAS/PC or it can be included when a new license for SAS/PC is obtained. In either case, please contact the Information Centre at 978-4990 for registration forms. If you would like to discuss IML further or see a demonstration of the product, please call Andrzej Pindor at 978-5045.

Mathematica: A Review

Andrzej Pindor
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Bill Fehner

Recently, we had the opportunity to evaluate Mathematica on an Apple Macintosh II. This review gave us a very favourable impression of the product, demonstrating that Mathematica is an extensive package that incorporates the functions of many other languages and packages into a single integrated framework. As well, many of the limits which you might expect to have to work around in a numerical package have been removed. This article shares some of our experiences with Mathematica.

While our copy of the package was for the Mac II, Mathematica is also available for Sun workstations — we expect to have it installed on a Sun 3-60 in the Statistical Numerical Analysis Computation office at UTCS in the near future. Mathematica will also be available for the NeXT computer in a few months. In fact, it will be included as part of the standard software shipped with the NeXT.

A number of important components of Mathematica are listed in *Table 1*. Although this is not an exhaustive list, it is representative of the power of the package.

A primary component of Mathematica is the Kernel. The Kernel is essentially the same for all implementations of the package and does

all of the processing of commands. The syntax of commands and many detailed examples are provided in a 700-page manual (which reads more like a good textbook).

The front end is unique to each implementation of Mathematica. The Macintosh front end takes very good advantage of the Macintosh environment. For someone familiar with this

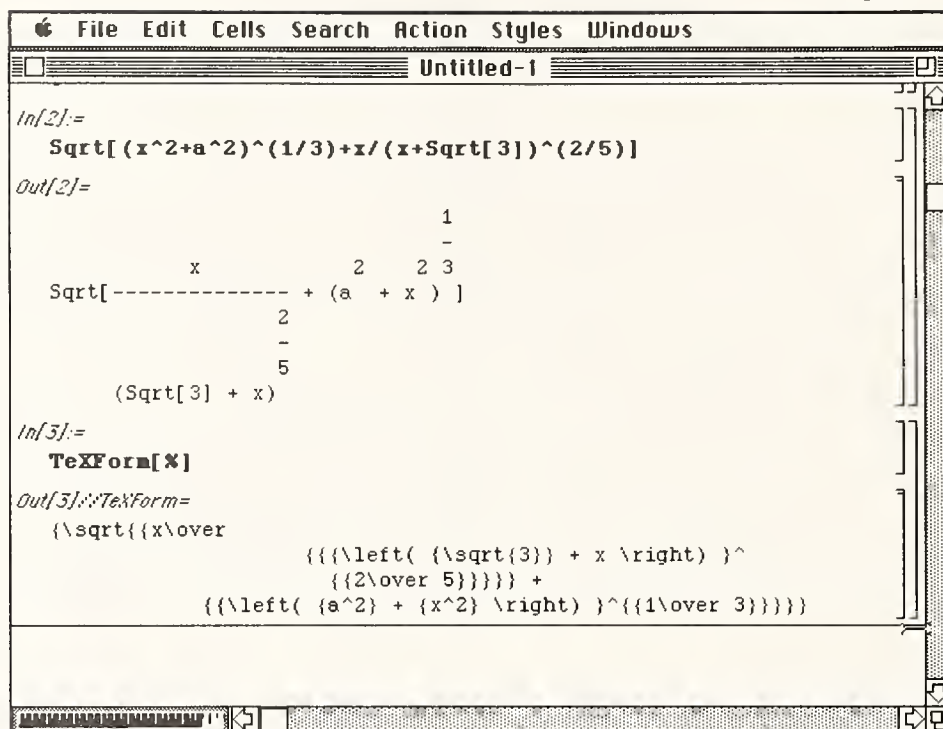
- algebraic manipulation including:
 - symbolic differentiation
 - symbolic integration
 - expansion and reduction of expressions
 - symbolic matrix algebra
- matrix language (reminiscent of APL)
- numerical evaluation of expressions including:
 - integration
 - differentiation
- extensive special function library
- workspace library with programs for particular application areas
- ability to program in several forms:
 - calculator mode
 - high level procedural (similar to C)
 - matrix language (similar to APL)
 - access to the LISP-like structures around which Mathematica is organized
- ability to make user extensions or modifications to built-in procedures
- arbitrary precision for numeric calculations
 - integers of any length
 - operations on rational numbers done exactly
 - precision for real numbers can be set at any time
- graphics utilities
 - two-dimensional plots
 - three-dimensional plots
 - animation

Table 1

Figure 1

environment, the 20-page explanation of this particular front end is more than adequate. All user commands and Mathematica responses are retained in the active document as you work and are accessible at any time by scrolling. Mathematica documents, called notebooks, are built of cells which can contain text, graphics or Mathematica expressions. These cells are organized hierarchically. Selecting a cell or group of cells for further processing is easy. The characteristics of cells can be changed at any time using a pull-down menu. For example, any cell or group of cells can be displayed or closed, which makes exploring the contents of a large notebook very easy because you can keep the unwanted information from cluttering the screen display. You have to try this feature to really appreciate its convenience. A portion of the online documentation that comes with the package is presented in the form of notebooks.

Mathematica has a number of ways of displaying and storing information. The input format is a linemode expression in the Mathematica language (see the top expression in *Figure 1*). Display format is a disappointing typewriter style display of equations (as shown in the second expression in *Figure 1*). It is possible to convert expressions to the TeX equation format (see the bottom expression in *Figure 1*). The final formatted version produced by TeX is quite acceptable, but this does nothing to reduce frustrations when working with complex expressions interactively. Expressions can also be displayed or stored as Pascal or FORTRAN code, thus



providing a fairly direct connection between Mathematica and these languages.

The graphics interface is quite good. Graphics are stored as PostScript code and can be directly printed on a laser printer. It is also possible to generate a set of related graphs and then request that they be displayed in sequence. It is time consuming to produce this form of animation, but the results are very effective.

Mathematica is a memory-hungry package. Although it can be installed on a Mac SE with 2 megabytes (MB) of memory, you won't be able to do too much with the package. The Mac II that we used had 8MB of memory, which is the amount recommended by the developers for use with Mathematica. We noticed that the memory-use indicator often rose to 6MB for moderately complex requests. For a group with several machines

linked by a network, it is possible to have the Kernel running on a large machine (e.g., a Mac II), with smaller front ends (e.g., Mac SEs) accessing this Kernel remotely. We have not yet had an opportunity to evaluate this configuration.

Problems

In using Mathematica, we discovered a number of problems. The most critical bug showed up in the way Mathematica saves and restores user-created functions. An algebraic expression was altered by Mathematica in a subtle, difficult-to-locate manner while going through the storing and retrieving process. Fortunately, in our situation the restored function gave clearly incorrect values, but the problem could be overlooked in other cases. To test the technical support provided, we reported this bug to the

developers. They were able to find a fix, and it will be included in version 1.2, due for release at the end of March.

Our frustrations with the screen display format of algebraic expressions was discussed above. The surprising ways in which symbolic manipulations were carried out on occasion were another source of frustration. For example, the indefinite integral of:

$$(a^2 - x^2)^{3/2}$$

was efficiently done, but the attempt to evaluate the indefinite integral of:

$$(a^2 - x^2)^{5/2}$$

was a disaster. Both of these integrals are in books of integrals and can be done by hand. Mathematica's symbolic expression reduction is powerful, but it sometimes needs considerable direction by the user. In general, there seems to be a large step between the use of simple features of Mathematica and access to the sophisticated abilities of the package.

We expect that Mathematica will meet the needs of a wide range of users. More people are now gaining access to powerful workstations on either a shared or standalone basis. Mathematica delivers the features of several other standalone packages in a single, integrated environment. If you would like to discuss Mathematica further or see a demonstration of it on a SUN 3-60, please call Andrzej Pindor at 978-5045.

UTCS Datapac Access to End

Ron Vander Kraats
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With the advent of networks such as NetNorth, ONet, and BITNET, the UTCS Datapac Access Facility has received little use over the past year. Therefore, UTCS decided to end this service in March. With the networks that are currently in place, alternative paths exist to satisfy most needs. Call Advising Services at 978-HELP to discuss the options available.

UTCS Dial-In Facilities

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Because of the decline in usage of the 300 bits-per-second line (978-6200), this line will be discontinued as a separate service. As of May 1, 1989, UTCS dial-in facilities can be accessed by phone at 978-3959 (300 and 1200 bps) and 978-7239 (2400 bps). This service will be available for testing as of April 10, 1989.

University Fiscal Year-End

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Users are reminded that the University Fiscal Year-End is April 30, 1989. This means that all blanket orders (Encumbrance Memos) raised for computing on a Departmental Appropriation Account (Ledger 1) will expire with the approach of that date.

The Comptroller's Office has given UTCS a billing close-off date of April 24, 1989, for charges to blanket orders. Therefore, the last day for accruing charges, to be applied to the blanket order, is April 21, 1989. Charges for the remaining few days of April (April 22 through 30 at 5:00 p.m.) will be billed in May.

In order to achieve uninterrupted service over the year-end, account administrators are advised to do the following:

1. Supply the Accounting Services Office with a blanket order (Encumbrance Memo) for the new budget year by April 15, 1989. It should clearly show the CAN (Customer Account Number) holder's name, the CAN number, the dollar amount, and the 1988/89 Encumbrance Memo number that it is replacing. In the case of a new account, where the CAN and previous Encumbrance Memo numbers are not available, "NEW ACCOUNT" should be indicated.
2. Service Access Codes (SACs) should be checked to determine whether they are required in the new year. If they are, the expiry date should be checked and changed if necessary. Spending limits are another important consideration. If total spending limit and usage to date require changes, this information should also be communicated before the end of April.

The discussion thus far has dealt mainly with the year-end situation as it normally affects instructional and administrative users. Researchers are also affected by the expiration of departmental subsidy blanket orders.

Account administrators are encouraged to discuss any doubts or difficulties arising with accounts or access codes at anytime by calling the Accounting Services Office at 978-7148.

Mail should be addressed as follows:

UTCS Accounting Services
4 Bancroft Avenue, Room 100B
University of Toronto

If you prefer to pay us a visit, we are at this address from 9:00 a.m. to 5:00 p.m., Monday through Friday.

Documents at UTCS

All vendor-produced documentation may be ordered through the UTCS Information Office, Room 201, 4 Bancroft Avenue. UTCS documents and selected vendor documents are also stocked there for purchase. For more information on prices, call Dale Wright at 978-4990. Whenever feasible, documents are made available online, and users are encouraged to print their own copies. On the VM machine, a special command has been provided for this purpose.

To print online documents on:

IBM VM/CMS

Type "help document"

GP UNIX

Use `ipr` command

The following examples relate to the table below. The document to be printed is the UTCS Guide to Census Tapes, called *CENSUS LISTING* on CMS and `/usr/doc/utcs/census` on GP UNIX. `<RETURN>` means RETURN or ENTER key.

CMS: `document <RETURN> <RETURN>`
 `laser census listing (forms yxle <RETURN>`

GP UNIX: `nohup ipr -8p -fyxle /usr/doc/utcs/census & <RETURN>`

UTCS Documents in hardcopy

New:

Previously announced:

Academic's Guide to Microcomputer Systems
Character Sets for Highspeed Printing
UTCS GUIDE TO PRODUCTS AND SERVICES: Introduction
UTCS GUIDE TO PRODUCTS AND SERVICES: Basics
UTCS GUIDE TO PRODUCTS AND SERVICES: Accounting
UTCS Catalogue: Numerical Products

UTCS Catalogue: Statistics Products
UTCS Catalogue: Text Products
UTCS Guide to Census Tapes
UTCS Guide to Kermit
UTCS Guide to Micro File Transfer Service
UTCS Guide to Text Processing on GP UNIX

UTCS Documents online

New:

Previously announced:

UTCS GUIDE TO PRODUCTS AND SERVICES: Introduction
UTCS GUIDE TO PRODUCTS AND SERVICES: Basics
UTCS Catalogue: Access, Part 1
UTCS Catalogue: Access, Part 2
UTCS Catalogue: Numerical Products
 Product-Function List
UTCS Catalogue: Statistics Products
 Product-Function List
UTCS Catalogue: Text Products
UTCS Guide to BMDP
UTCS Guide to Census Tapes
Recipes for Using Tapes on VM/CMS
UTCS Guide to FORTRAN on VM/CMS
UTCS Guide to GP UNIX
UTCS Guide to Highspeed Printing

CMS LISTING

INTRO
BASICS
ACCESS1

NUMCAT
NUMLIST
STATCAT
STATLIST
TEXTCAT
BMDP
CENSUS
QUIKTAPE
FORTRAN

PRINT

GP UNIX

`/usr/doc/utcs/intro`
`/usr/doc/utcs/basics`
`/usr/doc/utcs/access1`
`/usr/doc/utcs/access2`

`/usr/doc/utcs/textcat`

`/usr/doc/utcs/census`

`/usr/doc/utcs/gpunix`
`/usr/doc/utcs/print`

Forms Code

*
*
*
*
*
BXQD
*
BXQD
*
*
*
*
*
*

* Recommended forms code for the 8700 is YXLE unless otherwise stated.
† Use the 87set command. Type "help 87set".

Documents continued

UTCS Documents online continued

	CMS LISTING	GP UNIX	Forms Code
UTCS Guide to Kermit	KERMIT	/usr/doc/utcs/kermit	.
UTCS Guide to Micro Laser Printing Service	MICRLASR		.
UTCS Guide to SAS	SAS		.
UTCS Guide to SCRIBE	SCRIBE		.
(For printing instructions, see page 1 of document)			
UTCS Guide to Series/1 Terminal Use	SERIES		.
3270 Emulation:			
Cybernex APL100 and Volker Craig VC404	CYBER		.
DM1520	DM1520		.
Hardcopy Terminal	HARDCOPY		.
IBM 3101	IBM3101		.
IBM PC Kermit	PCKERMIT		.
SOROC IQ	SOROC		.
VT52	VT52		.
VT100	VT100		.
UTCS Guide to SPSS	SPSS		.
UTCS Guide to Text Processing on GP UNIX		/usr/doc/utcs/text	YXOG
UTCS Guide to TFW.MAK in SCRIBE	TFWMAK		.
UTCS Guide to VM/CMS	CMSGD		.
UTCS Guide to WSCRIPT	WSCRIPT		.
UTCS Rate Schedule (Commercial)	RATESCOM		†
UTCS Rate Schedule (External)	RATESEXT		†
UTCS Rate Schedule (Internal)	RATESINT		†

Other Documentation online

<i>Electronic Mail</i>			
A User's Guide to Electronic MAIL	MAILBOOK		YXOC
<i>Kermit</i>			
Kermit Protocol Manual	KERMITPM		YXOE
Kermit User Guide	KERMITUG		YXOF
<i>ProComm</i>			
ProComm Reference Manual	PROCOMM		YXOE
<i>VM BATCH Documents</i>			
VMBATCH User's Guide	VMBATCH		YXOA
VMBATCH Messages and Codes	VMBATMC		YXOA
<i>VMSECURE</i>			
VMSECURE User's Guide	VMSECURE		YXOE
<i>VM Tape Documents</i>			
TapeMap User's Guide and Reference	TAPEMAP		.
VMTAPE Messages and Codes	VTMSGGS		YXOE
VMTAPE User's Guide	VMTUSER		YXOE
<i>Waterloo SCRIPT</i>			
Reference Manual	WSCRIPTRF		YXLC
User's Guide	WSCRIPTUG		YXLC
Using SCRIPT in MVS/TSO	WSCRIPTSO		YXLC
Waterloo SCRIPT and a PostScript Printer	WSCRIPTPS		YXLC
Formula Processor Summary	WSCRIPTFP		YXLC
GML User's Guide	GMLUG		YXLC
GML Reference Summary	GMLRFSUM		YXLC

* Recommended forms code for the 8700 is YXLE unless otherwise stated.
† Use the 87set command. Type "help 87set".

Consulting and Enquiries

Applications Support & Advising Supervisor	Alex Nishri	BC214	978-7109
External Marketing Consultant	Ihor Prociuk	BC217	978-6875
Erindale College	Joe Lim	ER2035	828-5311
Information Office	Dale Wright	BC201	978-4990
Account & Access Code Enquiries)	Sylvia May	BC101B	978-7148
IBM PC Maintenance	Kam Mark	BC103	978-5050
Tape Library (Academic Services)	Susan Kovago	MP368	978-7319
Tape Library (Administrative Services)	Miranda Fong	MP368	978-6693
Terminal Service	Rosi Tseu	BC105	978-7087
UTCS Noncredit Short Courses	Irene Rosiecki	BC217	978-4565

Consulting & Advising Services:	978-HELP
CMS, and GP UNIX users:	ADVISOR
CMS Userid for mail problems:	POSTMSTR
System Status Enquiries (GP UNIX)	978-4318
System Status Enquiries (IBM)	978-7393
Interactive Services 300 (bps)	978-6200
Interactive Services 1200 (bps)	978-3959
Interactive Services 2400 (bps)	978-7239

UTCS Directory

Director:	Dr. Warren Jackson	BC118	978-8948	wcj@vm.utcs.utoronto.ca
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Operations Support	Dr. Bob Chambers	MP350	978-7092	
Systems Support	Bill Lauriston	MP331	978-3579	bill@vm.utcs.utoronto.ca

Committees on Computing

Committee on Administrative Computing	Chair	Janice Oliver	978-4322
UTCS Board	Chair	Prof J.F. Keffer	978-4984
Supercomputer Users' Group at U of T	Chair	Prof. J.M. Ting	978-4971
Research Board Standing Committee on Computing	Chair	Prof. C.C. Gottlieb	978-2986

Legend

BC = Bancroft Building
ER = Erindale
MP = McLennan Physical Labs
* NetNorth/BITNET/EARN

UTCS Terminal and Advising Sites

Names and Locations

Central Advising Office (CAO), 978-HELP
 Engineering Annex (EA, CDF), 11 King's College Road, Rooms 103, 107, 107B, 201, 203
 Erindale College (Erin), 828-5339, Mississauga Road, Erindale Campus, Rooms 2037, 2039A-B-C, 2045
 Robarts, Robarts Library, 130 St. George St., Room 1061A
 Sidney Smith (Sidney), 100 St. George St., Rooms 1071, 2105
 St. Michael's College, 121 St. Joseph St., Room 107
 Trinity College, 6 Hoskins Ave., Room 024
 Victoria University, 73 Queens Park Cres., Room 208

Access Hours

Sites	Hours of Access				Restrictions*	Advising
	Mon-Thurs	Fri	Sat	Sun		
CAO	10:00-18:00	10:00-18:00	closed	closed	Research	978-HELP
CDF	24 hrs	24 hrs	24 hrs	24 hrs	Undergrads	No
EA	24 hrs	24 hrs	24 hrs	24 hrs	None	978-HELP for Research
Erin (2039)Δ	9:00-17:00	9:00-17:00	12:00-16:00	12:00-16:00	Research	Rm 2005
(2045-46-47)	24 hrs	24 hrs	24 hrs	24 hrs	Undergrads	Rm 2005
(235)†	8:00-22:00	8:00-17:00	closed	closed	None	Rm 2046
Robarts	8:30-24:00	8:30-24:00	9:00-22:00	13:00-22:00	None	978-HELP for Research
Sidney	7:00-24:00	7:00-24:00	7:00-24:00	7:00-24:00	None	978-HELP for Research
St. Michael's	24 hrs	24 hrs	24 hrs	24 hrs	None	978-HELP for Research
Trinity	8:00-22:00	8:00-22:00	8:00-22:00	8:00-22:00	None	978-HELP for Research
Victoria	8:30-21:00	8:30-21:00	8:00-13:00	8:00-13:00	None	978-HELP for Research

Sites	Advising Hours
CAO	Monday through Friday, 10:00 - 18:00
Erin	Monday through Friday, 09:00 - 22:00

Legend

- * Research includes graduates, faculty, staff.
- \ Key access available.
- † Access restricted to building hours.

Terminal and Printer Access

Sites	PACX	Network Terminal Server	Printers	CDF/PC Terminals
CDF	N	N	Y	N
EA	Y	N	Y	N
Erin	Y	Y	Y	N
Robarts	Y	N	Y	Y
Sidney	Y	N	Y	Y
St. Michael's	Y	N	Y	Y
Trinity	Y	N	Y*	Y
Victoria	Y	N	Y*	Y

(Y=yes, N=no)

* CDF/PC only

UTCS Centrally Owned and Managed

Systems

IBM VM/CMS

- General Purpose Timesharing; access to NetNorth, BITNET, and EARN networks; access to CRAY X-MP/22
- 4381 P02 processor, 16 megabytes of memory
- CP operating system, VM/SP HPO R4.2
- CMS timesharing system, VM/SP Release 4
- RSCS spooling system, Release 3
- CRAY station Release 4

GP UNIX

Technical Assistance: 978-8853

- General Purpose Timesharing under SUN UNIX 3.2
- SUN 3/280, 8 megabytes of memory
- access to Linotronic typesetter
- offers a sophisticated and powerful environment for text processing
- offers a sophisticated programming environment suitable for commercial software development or testing
- full access to USENET, an electronic technical information exchange facility
- offers excellent electronic mail facilities and ability to send or receive mail from most computer networks worldwide, such as UUCPNET, ARPANET, NetNorth, BITNET, CSNET, CDNNET

Services

Communications & Technical Support

Primary Phones: 978-3787, 978-4967

- Communications Group provides communications systems, terminals, modems, data channels: consulting and installation.
- Field Service Group installs and maintains communications and computer systems, particularly IBM PCs, Micro Vaxes, and Macintoshes, on a contract basis or on a cost-per-call basis.
- provides consulting on computer systems technology and installs computer systems
- provides access between the IBM systems and machines using UNIX, VMS and other operating systems. Ethernet, Pronet, and IBM TRN technologies are used over various transmission media including optical fibre. More basic communications techniques are also used for moderate speed links.
- provides consulting on local area networking and installs LANS
- provides access to NetNorth (BITNET), the North American Universities Network; ONET, the Ontario Regional Network; and USENET, the UNIX networking fraternity
- provides gateway to the US Internet
- will provide a communications solution to department needs on a contractual basis

Information Centre

Primary Phone: 978-HELP

- Provides assistance in use of electronic messaging, including use of Local Area Networks (LANS); NetNorth/BITNET/EARN, the world Universities network; CDNNET, the Canadian X.400 network; ARPANET; CSNET; USENET; and other international connections.
- provides advising, consulting and documentation on:
 - command languages, including CMS and UNIX
 - high level languages, including FORTRAN, and PL/I
 - packages and libraries, including SAS, SPSS-X, BMDP, IMSL, and NAG
 - editors and formatters, including XEDIT, ed, nroff/troff
- provides general micro support
 - selection consulting for hardware and software
 - Micro Lab for evaluation of hardware and software
 - advice on University discounts
 - media conversion and data transfer
 - operates UTCS Microcomputer Bulletin Board System
 - offers Micro Laser Printing Service
 - offers 35mm slide production service using Polaroid Palette
 - administers Local Area Network of PCs for Education Facility
 - administers Macintosh Education Facility
- high quality typesetting
- installs and maintains application packages
- provides short courses and seminars on the more popular services and software packages

The principal mandate of UTCS is to plan, implement, and operate facilities and "common-carrier" networks, and to plan and support divisional, departmental or project computer facilities as requested.

Facilities Managed by UTCS

Administrative Computing

- administrative IMS/VS, DB/DC, DB2, Batch, and TSO
- 4381-R14 processor, 32 megabytes of memory
- MVS operating system

Computer Disciplines Facility/UNIX

- SUN 3/280s, 8 megabytes of memory (zero.cdf)
 - Computer Science interactive access
 - SUN UNIX 3.5

- SUN 3/280s, 16 megabytes of memory (one.cdf)
 - Computer Science interactive access
 - SUN UNIX 3.5

Computer Disciplines Facility/PC

- 97 TI Professional Computers connected in a Local Area Network
- introductory Computer Science instruction
- MS-DOS with Turing environment

Erindale College Systems

- VAX 8200, 8 megabytes of memory
 - instructional access using VMS
 - research access

- VAX-11/750, 5 megabytes of memory
 - instructional access using UNIX (Berkeley UNIX 4.3BSD)

Institutional Relations System

- VAX-11/750, 8 megabytes of memory
 - database services to the owner departments using VMS

EPAS Facility

- 4361-5 processor, 16 megabytes of memory
- general VM/CMS services to the owner departments

Ontario Centre for Large Scale Computation (OCLSC)

- Cray Research Inc. X-MP/24
- 2 processors, 4 megawords main memory
- solid state disk (SSD) with 64 megawords of storage
- COS 1.17 operating system
- VAX 8350 + MicroVAX II and VAX750 provide VMS front-end services

Software List

SOFTWARE LIST for MICROCOMPUTERS

The following are microcomputer software packages for which UTCS can provide either support or some information. As with mainframe products, micro packages receive full support (Class A), limited support (Class B), or no active support (Class C). The specific criteria differ from those for mainframe classes and are outlined in the Academic's Guide to Microcomputer Systems.

Package/Compiler	Version	Environment	Support
<u>Application Development Tools</u>			
BASIC			
GW BASIC	—	MS-DOS	B
C			
Microsoft C	5.1	MS-DOS	B
MPW C	2.0.2	Macintosh	B
WATCOM C & Express C	6.0	MS-DOS	B
FORTRAN			
IBM FORTRAN/2	1.0	MS-DOS 3.3 & OS/2	B
Language Systems FORTRAN	1.0	Macintosh	C
Microsoft FORTRAN	4.0	MS-DOS	B
WATCOM WATFOR-77	3.0	MS-DOS	A
Pascal			
MPW Pascal	2.0.2	Macintosh	C
TURBO Pascal	—	MS-DOS	B
Tools			
ResEdit	1.2d0	Macintosh	B
HyperCard	1.2.1	Macintosh	A
Macintosh Programmer's Workshop	2.0.2	Macintosh	B
WATCOM GKS	1.3	MS-DOS	B
<u>Communications</u>			
File Transfer & Terminal Emulators			
Kermit	0.8(35)	Macintosh	A
Kermit	2.30	MS-DOS	A
Kermit	—	Apple II DOS	C
Kermit	—	CP/M	C
Lap-Link DeskLink	1.0	MS-DOS	B
Lap-Link Mac	1.2	Macintosh	B
Lap-Link PC	2.16	MS-DOS	B
MacTerminal	2.2	Macintosh	B
PC TALK3	—	MS-DOS	C
PC PLOT-III	—	MS-DOS	C
ProComm	TU 2.4.2	MS-DOS	A
Red Ryder	10.3	Macintosh	B
Network Systems			
AppleShare	2.0.1	Macintosh	B
Novell Advanced Netware	2.0a	MS-DOS	B
STARLAN	—	MS-DOS	B
TOPS	2.0	Macintosh	B
TOPS	2.0	MS-DOS	B
Network System Utilities			
Inter•Poll	1.0	Macintosh	C
<u>Database Managers</u>			
4th Dimension	Int. 1.03	Macintosh	B
AskSam	3.0	MS-DOS	B
Clipper	S87	MS-DOS	B
DATAEASE	2.5	MS-DOS	B
dBASE II	—	CP/M	B
dBASE III Plus	1.1	MS-DOS	A
FoxBASE	2.14u	MS-DOS	C
Notebook II	2.03	MS-DOS	C
REFLEX	—	MS-DOS	B
ZyINDEX	—	MS-DOS	B
<u>Desktop Publishing</u>			
PageMaker	3.01	Macintosh	A
PageMaker	3.0	MS-DOS	A

Software List continued

Package/Compiler	Version	Environment	Support
Ready Set Go	4.0	Macintosh	C
Ventura	2.0	MS-DOS	B
XPress	1.0	Macintosh	C
<u>Electronic Mail</u>			
Microsoft Mail	1.36	Macintosh	B
QuickMail	1.0	Macintosh	B
<u>Graphics</u>			
Charting			
35mm Express	4.02	MS-DOS	B
Cricket Graph	1.2	Macintosh	C
Freelance Plus	2.01	MS-DOS	B
Harvard Graphics	2.1	MS-DOS	B
Lotus 1-2-3	2.01a	MS-DOS	B
Microsoft Excel	1.5	Macintosh	B
Microsoft Excel	2.0	MS-DOS	B
SigmaPlot	—	MS-DOS	C
Draw and CAD			
Aldus Freehand	1.0	Macintosh	B
Cricket Draw	1.1	Macintosh	C
Generic CADD	3.0	MS-DOS	C
MiniCad	4.05	Macintosh	C
Illustrator	1.0	Macintosh	B
Illustrator88	1.6	Macintosh	B
MacDraft	1.2b	Macintosh	C
MacDraw	1.95	Macintosh	A
MacDraw II	1.0v1	Macintosh	B
Windows Draw	1.02	MS-DOS	C
Image and Scanning			
ImageStudio	1.05	Macintosh	B
Publish Pac	2.0	Macintosh	B
Publish Pac	2.1	MS-DOS	B
Text Pac	2.0	MS-DOS	B
Paint			
DR HALO	1.23	MS-DOS	C
MacPaint	2.0	Macintosh	A
Microsoft Paintbrush	2.0	MS-DOS	C
PC Paintbrush	2.5	MS-DOS	C
SuperPaint	1.1	Macintosh	B
Windows Paint	2.03	MS-DOS	C
Plotting Subroutines			
WATCOM GKS	1.3	MS-DOS	B
<u>Numerical</u>			
Derive	1.14	MS-DOS	C
Eispack	n/a	MS-DOS	C
Eureka	n/a	MS-DOS	C
GAUSS	2.0	MS-DOS	B
IMSL	10.0	MS-DOS	A
Linpack	n/a	MS-DOS	C
MathCAD	2.0	MS-DOS	C
muMATH-83	4.12	MS-DOS	C
Solver-2	---	MS-DOS	C
<u>Operating Systems</u>			
IBM PC, PS/2, and compatibles			
IBM OS/2	1.0	n/a	B
IBM PC-DOS	3.3	n/a	B
Microsoft MS-DOS (incl IBM PC-DOS)	3.2	n/a	A
Microsoft Windows	2.03	n/a	A

Software List continued

Package/Compiler	Version	Environment	Support
Microsoft Windows 386	2.03	n/a	C
Macintosh II, Macintosh SE, and Macintosh Plus			
Finder	6.1	n/a	A
MultiFinder	6.0.1	n/a	A
System	6.0.2	n/a	A
Apple II			
Apple II DOS	3.3	n/a	C
CP/M	2.20	n/a	C
ProDos	1.0	n/a	C
<u>Sound</u>			
SoundWave	1.0	Macintosh	B
MacRecorder	1.0	Macintosh	B
<u>Spreadsheet</u>			
APPLEWORKS	—	MS-DOS	C
HAL	1.0	MS-DOS	B
Lotus 1-2-3	2.01a	MS-DOS	B
Microsoft Excel	1.5	Macintosh	B
Microsoft Excel	2.0	MS-DOS	B
Multiplan	1.5	Macintosh	C
<u>Statistical</u>			
BASS	88.10	MS-DOS	C
MACSPIN	1.5	Macintosh	C
Minitab	82.1.1	MS-DOS	C
PowerStat	1.04	MS-DOS	C
SAS/PC	6.03	MS-DOS	A
SPSS/PC+	3.0	MS-DOS	A
STATPRO	2.0c	MS-DOS	C
STATWORKS	1.2	Macintosh	B
SYSTAT	3.2	Macintosh	B
SYSTAT	3.2	MS-DOS	B
<u>Word Processing</u>			
Guide	2.0	MS-DOS	C
FinalWord II	2.0	MS-DOS	C
MacWrite	5.01	Macintosh	B
Manuscript	1.0	MS-DOS	C
Microsoft Word	3.01	Macintosh	A
Microsoft Word	4.0	MS-DOS	A
Nota Bene	3.0	MS-DOS	B
Nota Bene SLS	3.0	MS-DOS	B
PC-TeX	2.1	MS-DOS	B
Sprint	1.0	MS-DOS	B
T ³	—	MS-DOS	C
Volkswriter Scientific	—	MS-DOS	C
WordPerfect	4.2 & 5.0	MS-DOS	A
WordPerfect	1.0	Macintosh	C
WordPerfect Library	2.0	MS-DOS	C
WordStar	3.3	MS-DOS	B
<u>Utilities</u>			
Apple Turnover	—	MS-DOS	A
FASTBACK	—	MS-DOS	B
Norton Utilities	4.0	MS-DOS	A
Copy II Disk	7.1	Macintosh	B
Mace Utilities	—	MS-DOS	B
MacZap	5.1	Macintosh	B
Sidekick	—	MS-DOS	B
SuperKey	—	MS-DOS	C
TURBO Lightning	—	MS-DOS	C
XenoDisk	1.41	MS-DOS	A

Software List continued

SOFTWARE LIST for MAINFRAME COMPUTERS VM/CMS, UNIX

Each programming language or package available at UTCS has a support level. In general, Class A Products receive full support, Class B limited support (as time and resources allow), Class C no active support.

For complete details of UTCS product support policy, see the UTCS GUIDE TO PRODUCTS AND SERVICES: Introduction.

Package/Compiler	System	Support	Version
<u>Communications</u>			
Kermit	VM/CMS	A	---
Kermit	UNIX	B	4C(058)
FTS	VM/CMS	A	---
MAIL/MAILBOOK	VM/CMS	A	86.359
MICROLASER	VM/CMS	A	---
macget/macput	UNIX	C	---
netcopy, netexec, to (NetNorth Tools)	UNIX	B	---
xmodem	UNIX	C	---
ftp,rsh,rlogin,telnet,rcp (Access via TCP/IP to most of the networked machines on all three campuses)	UNIX	B	---
rn/Pnews	UNIX	B	---
mail,mh,Mail	UNIX	-	---
<u>Graphics</u>			
PLOTBASIC (FORTRAN)	VM/CMS	C	---
SAS/GRAPH	VM/CMS	A	5.16, 5.18
<u>Languages</u>			
ASSEMBLER(F)	VM/CMS	C	---
Concurrent Euclid	VM/CMS	C	1.9
FORTUTILS	VM/CMS	A	2.2
PL/I OPT Compiler	VM/CMS	B	1.5.1
REXX	VM/CMS	A	---
SNOBOL 4	VM/CMS	C	3.5
Turing	VM/CMS	C	---
VS FORTRAN	VM/CMS	A	1.4.1
VS Pascal	VM/CMS	C	2.2
Waterloo C	VM/CMS	C	1.3
WATFIV	VM/CMS	C	V2L0
WATFOR-77	VM/CMS	A	1.3
cc	UNIX	A	---
f77	UNIX	C	---
ratfor	UNIX	C	BSD std.
ttc	UNIX	C	---
pc	UNIX	C	BSD std.
yacc	UNIX	C	---
awk	UNIX	C	---
adb,dbx	UNIX	C	BSD std.
<u>Numerical</u>			
IMSL	VM/CMS	A	9.2,10.0
LINPACK	VM/CMS	C	---
NAG	VM/CMS	A	Mark 11
<u>Statistical</u>			
BMDP	VM/CMS	A	Level 85, Level 87
Minitab	VM/CMS	B	5.1
NAG	VM/CMS	A	Mark 11
NTSYS	VM/CMS	C	1987
SAS	VM/CMS	A	5.18
SPSS*	VM/CMS	A	2.2

Software List continued

Package/Compiler	System	Support	Version
<u>Text Processing</u>			
SCRIBE	VM/CMS	C	4(1400)-1
Waterloo SCRIPT	VM/CMS	B	86.1
XEDIT	VM/CMS	A	---
8700 Pseudotypesetting	VM/CMS	C	n/a
MICROLASER	VM/CMS	A	---
ed	UNIX	A	---
vi	UNIX	C	---
cmacs	UNIX	C	---
spell	UNIX	C	---
diction/explain	UNIX	C	---
eqn	UNIX	B	---
tbl	UNIX	B	---
pic	UNIX	C	---
troff	UNIX	B	---
nroff	UNIX	B	---
TeX	UNIX	C	---
<u>Utilities</u>			
FORTUTILS	VM/CMS	A	2.2
TPRINT	VM/CMS	C	---
crypt	UNIX	A	BSD std.
compress	UNIX	C	BSD std.
csh	UNIX	B	BSD std.
diff	UNIX	A	BSD std.
grep	UNIX	A	BSD std.
ipr	UNIX	B	---
learn	UNIX	C	BSD std.
patch	UNIX	C	---
sed	UNIX	A	BSD std.
sort	UNIX	A	BSD std.
sh	UNIX	A	BSD std.
tar	UNIX	A	BSD std.
uniq	UNIX	A	BSD std.

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